GUAYULE RESEARCH

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY

AND THE

SUBCOMMITTEE ON DEPARTMENT OPERATIONS,
RESEARCH, AND FOREIGN AGRICULTURE

OF THE

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GUAYULE RESEARCH

THURSDAY, MARCH 24, 1983

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY; COMMITTEE ON AGRICULTURE, SUBCOMMITTEE ON DEPARTMENT OPERATIONS, RESEARCH, AND FOREIGN AGRICULTURE,

Washington, D.C.

The subcommittees met, pursuant to notice, at 9:37 a.m., in room 1301, Longworth House Office Building, Hon. George E. Brown, Jr. (chairman of the Subcommittee on Department Operations, Research, and Foreign Agriculture) presiding.

Present: Representatives Brown, Walgren, MacKay, Valentine, Gregg, Boehlert, Sensenbrenner, McGrath, Skeen, Bateman, Penny, Volkmer, Roberts, Evans, and Franklin.

Also present: E de la Garza, ex officio, Agriculture Committee.

Staff present: Charles Benbrook, staff director; Gerald Jorgensen, minority consultant; Christine Abram, staff assistant, Subcommittee on Department Operations, Research, and Foreign Agriculture; and Robert O'Neill and Maryanne Bach, Subcommittee on Science Research and Technology.

Mr. BROWN. Good morning. The subcommittees will come to order.

This morning we are in the relatively rare exercise of having two subcommittees jointly holding a hearing on the extension of the Native Latex Commercialization and Economic Development Act of 1978. This act involves, to some degree, the interests of both the Science and Technology Committee and the Agriculture Committee. Therefore, in order to avoid some duplication, we have agreed to jointly conduct a hearing on this subject. I appreciate the cooperation of Congressman Walgren, who serves as chairman of the relevant subcommittee on the Science Committee.

As I said, we are here today to hear testimony on the Native Latex Commercialization and Economic Development Act of 1978, with an eye toward reauthorizing that act, which expires later this year. The purpose of that act was to attempt to bring to commercial production the guayule plant, a shrub which grows in semiarid areas and produces natural rubber. The need for this commercial development stems from the fact that we are 100-percent dependent upon imports for natural rubber and that a natural rubber shortfall has been predicted to occur in the near future. I view this legislation as essential to our national security, vital to the continued economic success of southwestern agriculture, and a model of

the kind of research and development work that we should be conducting to bring new products to the marketplace.

However, this program has received only modest Federal support, with the Department of Agriculture and the National Science Foundation providing the steadiest support. The Department of Commerce has only been modestly involved. State governments, however, have noticed the potential of the commercial development of guayule and have chipped in a considerable amount of money. The private sector, mainly the major rubber companies, has been involved but has dropped many of their efforts due to the economically depressed rubber industry.

All of this adds up to a job left undone and a need which still persists. We are still dependent upon imports for natural rubber and we still have a need to develop water-conserving crop alternatives for the arid Southwest. But we also have a larger task before us of which this program is just the first stage.

As resource inputs to agriculture—energy, chemicals, and water—become more expensive, we need to develop farming systems which conserve these resources. We need to develop new crops and new uses for existing crops to benefit a depressed farm sector, and we need to better coordinate the various agriculture-related R&D programs which nearly every Federal department conducts.

This native latex program, viewed in the larger sense, is not just an effort to develop one crop in one region. It is a challenge to develop a system which will be of use in all parts of the country to develop new crops and new crop uses. Meadow foam, cranbe, buffalo gourd, gopher weed, jojoba—these are strangely named plants growing in every region which may hold commercial promise as renewable sources of critical materials. If we are to have a credible agriculture research program or a working national materials policy, we must explore these alternatives. Remember, at one point just a few decades ago soybeans and sunflowers were on this list of crops.

I am anxious to hear today what progress has been made in this effort. I am also anxious to hear how we can better design this effort to achieve greater success in the future.

Now I will ask Mr. Roberts if he has an opening statement.

Mr. ROBERTS. Yes, Mr. Chairman, I would like to ask the chairman's permission to insert the full statement in the record at this point.

Mr. BROWN. Without objection, so ordered.

[The prepared statement of Mr. Roberts follows:]

STATEMENT BY THE HONORABLE PAT ROBERTS

March 24, 1983

Mr. Chairman, the purpose of our joint hearing today is to receive testimony as to the wisdom of reauthorizing appropriations for Public Law 95-592, the Native Latex Commercialization and Economic Development Act of 1978. Our two subcommittees meeting today met in 1978 and after due deliberation set in motion what finally became Public Law 95-592. Now we are being asked to provide authorization for adequate funding so that additional research and development efforts can be accomplished in order that the commercialization of native latex based on the cultivation of the guayule plant can be carried forward.

Congress in passing the original legislation recognized that development of a domestic source of natural rubber was of importance to our economy and to our defense effort. Total dependency on foreign sources for natural rubber, together with increased world demand, requires a look-see at whether domestic production of guayule can help us out of this predicament.

What we need answered in this hearing is the amount of money that has been spent in support of the present effort, an indication of what has been accomplished since enactment of this legislation, and an assessment of where we go from here. Have we reached a point where it would be better to abandon the effort, or have we made significant progress in determining the economic feasibility of the commercialization of native latex so that we should proceed with further initiatives?

The witnesses assembled here today should be able to give us the testimony we need to help us make our decision. Thank you, Mr. Chairman.

Mr. ROBERTS. I will summarize from that statement, simply saying that Congress in passing the original legislation, Public Law 95-592; recognized that the development of a domestic source of natural rubber was of importance to our Nation, our defense effort, and our economy, and that total dependency on foreign sources for natural rubber, together with increased world demand, requires a real look-see at whether domestic production of guayule can help us out of this predicament.

What we need answered in this hearing is the amount of money that has been spent in support of the present effort, an indication of what has been accomplished since the enactment of this legislation, and an assessment of where we go from here.

Have we reached a point where it would be better to abandon the effort or have we made significant progress in determining the economic feasibility of the commercialization of native latex, so that we should proceed with further progress.

The witnesses assembled here today should be able to give us the testimony we need to help make our decision.

That would conclude my statement, Mr. Chairman.

Mr. BROWN. Thank you very much for that statement, Pat.

I will now call on Mr. Walgren for any opening statement he may have.

Mr. WALGREN. Thank you very much, Mr. Chairman.

Today, on behalf of the Subcommittee on Science Research and Technology, it is certainly of great interest for me to be here as we focus on activities that have been conducted under the Native Latex Commercialization and Economic Development Act of 1978.

The cultivation and the use of the guayule rubber plant have several very important consequences for the Nation.

First, the United States currently imports all of its natural rubber supply. This dependency can be economically risky, as in the case of crude oil, the U.S. economy is subject to a disruptive supply cutoff or interruption. Long gas lines and skyrocketing fuel prices have shown us that we continue to be vulnerable to foreign sources of critical commodities at our peril.

Second, natural rubber is essential for the manufacture of products used by the military, such as tires for vehicles and aircraft. Remaining totally dependent on foreign sources of natural rubber would certainly endanger the military preparedness which may be extremely crucial to the national interest.

Third, guayule, with its low water requirements and its ability to grow in arid conditions, would allow us to use land that would not otherwise be productive.

It seems to me these factors make guayule an important and useful crop.

Another aspect of the guayule program is the larger question of research and development yielding knowledge that can lead to new products in the marketplace. Government, university, and industry must cooperate to foster new technologies for the future. Through a well-planned research and development effort rubber from the guayule plant may be put to immediate use or the technology developed may be very useful in the future.

Further, the guayule research and development program could serve as a model for research and development on other crops that may bear energy and materials useful in our private economy.

It is a matter of very direct interest for my subcommittee to join with the Agriculture subcommittee chaired by Mr. Brown in this hearing. As you all know, Mr. Brown was instrumental in starting this program with the passage of the original Native Latex Commercialization Act in 1978, and together these two subcommittees have a very real interest in how the program is progressing and trying to encourage success.

We certainly look forward to these hearings and appreciate the opportunity to join you in them.

Mr. BROWN. Thank you, Mr. Walgren.

Mr. Skeen, the fourth member of our group here this morning, serves on both committees, as I do.

Do you have any opening statement, Mr. Skeen?

Mr. SKEEN. Thank you, Mr. Chairman.

I'm just pleased to be with you here this morning because we in the Southwest have a particular interest in the cultivation and the husbandry involved in this particular crop. We have a gentleman from New Mexico State University, Dr. Niehaus, who will be one of the witnesses here today. I think it is going to be a very illuminating topic. I appreciate being involved.

Thank you, Mr. Chairman.

Mr. BROWN. I might mention that some of us earlier this morning had an opportunity to meet with the Assistant Secretary of Agriculture, who described the radical change that has taken place in the pattern of exports from the European Common Market, agricultural exports. From being a deficit area 10 years ago in certain important commodities, such as sugar and wheat and a number of others, they are now major exporters in that market. In other words, as a result of Government policies, they have drastically altered their capabilities in the areas of agriculture which they thought were essential to their welfare.

I see this as an example of where the economic needs of an area such as Europe have caused them to drastically restructure their agricultural patterns. I look on the guayule program as being an example of perhaps an area of similar need in this country, where an enlightened policy would help to relieve us of our dependence upon imports of a product vital to our economy. This, of course, is part of the importance of this program.

Let me now call on our first witness, Dr. Orville Bentley, Assistant Secretary of Agriculture for Science and Education, who is accompanied by a distinguished group of colleagues: Dr. Marvin Jensen, Dr. Clarence Grogan, and Dr. Richard Wheaton.

If you want to say something nice about all these gentlemen, Dr. Bentley, you may do so.

We welcome you here this morning.

STATEMENT OF DR. ORVILLE BENTLEY, ASSISTANT SECRETARY OF AGRICULTURE FOR SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE, ACCOMPANIED BY DR. RICHARD WHEATON; DR. CLARENCE GROGAN; AND DR. MARVIN JENSEN

Dr. BENTLEY. Thank you, sir.

Chairman Brown and Chairman Walgren, it is a pleasure for me to be here this morning to talk on the topic of native latex and its commercialization and development.

I note that each of you has summarized the situation and the potential for the crop, so we are pleased to talk about it with you and summarize our testimony.

I have a written testimony which I have submitted for the record. I would like, though, to take just a few minutes, Mr. Chairman, to highlight a couple of points that I think would help us get an understanding of where we are now and to answer some of the questions that have been posed by you or other members of the committee.

Mr. BROWN. As usual, Dr. Bentley, the full text of your statement will be included in the record following your oral presentation. You may feel free to summarize or abstract any way you wish.

Dr. BENTLEY. Thank you.

Following that, I would like to call on my colleagues to make additional brief statements.

The Departments of Agriculture and Commerce have taken the lead for carrying out the provisions of the Latex Act. The National Science Foundation and the Department of Interior's Bureau of Indian Affairs have supported the work of the Joint Commission, which I head.

The act also states that the chair of the Commission should rotate every 2 years. By agreement, though, between Agriculture and Commerce, the chairmanship for the Joint Commission has been in Agriculture, mainly because so much of the work has to do with agronomic affairs and evaluation of guayule as a crop.

It is also important to note here and support what has already been said about this topic. The Departments of State, Energy, Defense, and the Federal Emergency Management Agency work closely together and work closely with the Commission.

Within Agriculture, the Cooperative State Research Service, the Agricultural Research Service, the Office of International Cooperation and Development, the Soil Conservation Service, and the Farmers Home Administration have supported both the work that is being done in this country and the contacts that have been made internationally relative to this crop.

We are also pleased that the California Department of Food and Agriculture has assisted the work with demonstration projects and worked with the Commission.

Another set of linkages that has been very important in development of the work under this Joint Commission has been the regional efforts. It involves the State land grant universities, the Agricultural Research Stations, and they have been able to coordinate their work at a State level and on a regional level as well.

The four States involved in this effort, along with the Agricultural Research Service, are Arizona, California, Texas, and New Mexico. We think that this joint effort is a very important aspect of the program, and it has done much to promote the work that is in progress and that we plan to do in the future.

I think that the organization is in place and that we are moving along in a coordinated effort.

Very briefly, the program so far has involved an expenditure of approximately $8.3 million, nearly $8.4 million rather, and expenditures have gone in 1980 from about $1.5 million to $2.3 million in 1981; in fiscal year 1982, $2.2 million roughly; and in 1983, about $2.35 million. The total expenditure expended over the period, as I said, is $8.377 million.

There has been an increase in the program over the period of time that the act has been in force and that the cooperative venture has been proceeding.

The funds allocated for 1983, fiscal year 1983, again are $2,356,000, and there is $1 million of nonresearch support, so that the total this year that we plan for expenditure is $3.356 million.

That is roughly the magnitude of the program under way. As I have said, it is a cooperative effort involving the Agricultural Research Service, the Agricultural Experiment Stations, as far as Agriculture is concerned, and cooperation with other agencies. There will be comments about this later on.

I think that I could just summarize our situation by reading a paragraph from the statement. We support the native latex development program, and we look forward to evaluation of the crop as a potential source of latex and for natural rubber.

The administration did not propose funding the Native Latex Act for fiscal year 1984 because of budgetary limitations. We recognize that the act has allowed and promoted coordination and cooperation among Federal and State agencies and has helped focus the attention on needed research in connection with development of guayule.

We think, though, that we can continue this cooperation under existing authorities. Therefore, we would propose to maintain our commitment to the program that we have under way for 1983 and continue in 1984 as a part of our ongoing activities for evaluating new crops and the potential of guayule.

Mr. Chairman, at this time, if I may, I would like to call on Dr. Wheaton, for a brief comment about the program.

Mr. BROWN. That will be fine.

Dr. Wheaton, we will be happy to hear your statement.

Dr. WHEATON. Thank you, Mr. Brown and Mr. Walgren.

It is a pleasure to be here and testify before the subcommittees today.

My position is program manager in the Department of Agriculture for the Department's program of guayule and also as secretary to the Commission.

As Dr. Bentley has pointed out, the amount of funds that have been actually authorized for expenditure in the Department's funds—there is still another quarter of a million dollars that goes into just that support, and this has helped us a great deal in our coordination efforts. We also find there are other funds coming

from other agencies, like the Department of Energy and the Department of the Army and others that are interested in applying some funds to do, help and assist with some of this work as well.

The State Agricultural Experiment Stations the Agricultural Research Service, and the Cooperative State Research Service work very closely, and this has been brought about because we do have a staff group that works from each of the agencies with the Joint Commission to help coordinate these activities.

One of the things that we have tried very hard to do is a four-State region coordination effort, and we think that you will see by the report that was turned in and other testimony that this has actually occurred.

There are two programs that the ongoing research that is carried on by all the agencies are two programs. One is a foundation seed increase program so that we can assure industry they will have good quality, high rubber-producing seed and the other is the regional research trials. These will be mentioned briefly in the other testimony.

I would call your attention, gentlemen, to the fact that the Joint Guayule Commission has provided to the Congress a 2-year report, and many of the answers will be provided in that 2-year report.

At this time I will conclude my testimony.

Mr. BROWN. Thank you very much, Dr. Wheaton.

Dr. BENTLEY. As Dr. Wheaton pointed out, he serves as a staff officer for the Commission and has been very helpful in this work.

I would now like to turn to a brief summary of the work that is being done primarily under the special grants and through the agricultural experiment stations. To do this, I will call on Dr. Grogan from CSRS.

Mr. BROWN. Proceed, Dr. Grogan.

Dr. GROGAN. Thank you, Mr. Chairman.

The Cooperative State Research Service monitors nine native latex grants to the four States where guayule is grown. These grants that were made available through the Congress under the Native Latex Act. The projects are covered in appendix 8 of the report to the Congress.

These laboratory and field studies provide knowledge and technology in the following areas: Optimization of rubber production through plant breeding and selection; breeding for increased rubber yield; improvement of the Arizona guayule germplasm collection; seed production practices for commercialization; water use and production practices; management practices for growing in gypsenous saline water; identification and control of diseases; stand establishment and cultivation practices in west Texas; and influence of stand establishment methods and herbicides on rubber production.

These grants have been very successful in addressing each of these areas.

The major emphasis in guayule at the University of Arizona has been on the evaluation of existing germplasm for rubber yield and the effect of irrigation regimes, along with varieties, plant spacings, planting dates, and clipping on rubber production. These areas are extremely important if we wish for the eventual success of the program itself.

At the University of California at Riverside considerable work is in progress on looking at the germplasm and certain types of crosses from which new and unique germplasm may be developed. Also, they are looking at the propagation procedures. It was found that rooting guayule on semihard cuttings in mist chambers has been very effective and will have an impact on the propagation of new cultivars. This is a very important area if we wish to make progress through the propagation procedures versus the direct seeding type of stand establishment.

The bioregulator will be touched on in just a few minutes by one of the other members, and then breeding hybrids and testing for vigor.

Also in California, a call yesterday revealed that they have had increased vigor and rubber content in certain types of crosses called apomictic crosses. In other words, they are self-producing, and we have yield increases of 60 percent better than the best of the present USDA lines.

If we assume that the old varieties under excellent conditions produce 500 pounds per acre, and the best USDA line produces about 50 percent more, these new ones have the potential of being 60 percent better than the best of the USDA lines.

Mr. BROWN. Excuse me just a moment. I am having trouble computing all those percentages in my mind. Would you tell us what that means, starting with the base of 500——

Dr. GROGAN. 500 pounds.

Mr. BROWN. You have 2 percentage increases. Does that bring us to 1,000?

Dr. GROGAN. If we look at the 500-pound base of the old types and if the USDA lines produce roughly 50 percent more than those, that is up to 750 pounds. Then if we look at the new selections that have the potential, it would be 60 percent beyond the 750.

Mr. BROWN. 1,100 or 1,200 hundred pounds. OK. Thank you.

Dr. GROGAN. Therefore, we are getting beyond a thousand pounds.

Another way in which we can get new potentially high-yielding rubber content in our guayule is through wild relatives. This area of research looks increasingly interesting and very promising.

The same is true going back to the more basic type of germplasm. If we can accumulate, through the sexual process, certain lines and get high yields from those and then by accumulating these genes in our stocks, we can go into the apomictic types that will be self-perpetuating. This is another route by which we can develop some superior cultivars.

New Mexico State has made very rapid advances in the whole herbicide, rubber, and stand establishment areas. They found that as long as the stand itself is not reduced, there are no adverse effects on rubber content of guayule.

Weeds are a very serious problem with guayule stand establishment.

Gypsenous saline research is in process on new ways by which stands can be established using water in Texas and in Arizona. They also are looking at germplasm for tolerance to salt conditions. Both of those areas look extremely interesting.

Some other research areas in the Southwest are: cold tolerance and drought tolerance. All of these, through breeding and selection programs, are promising at this time.

That concludes my testimony.

Mr. BROWN. Thank you, Dr. Grogan.

Dr. Bentley.

Dr. BENTLEY. I would like to call on Dr. Marvin Jensen, who is with the Agricultural Research Service located in Colorado. He is coordinating the report on the Agricultural Research Service activities, but I would stress again that this is a cooperative venture involving the States and ARS.

Dr. Jensen.

Mr. BROWN. Dr. Jensen, where are you located in Colorado?

Dr. JENSEN. I am currently located at Fort Collins, Colo.

Mr. BROWN. Are you the custodian of the seeds there?

Dr. JENSEN. No, I am not, sir.

Mr. BROWN. OK. You may proceed.

Dr. JENSEN. Thank you, Mr. Chairman.

As was indicated earlier, the Agricultural Research Service had a breeding program which was terminated in 1959. We initiated a small program in fiscal year 1978. This program was expanded in 1980, 1981, and 1982. It has been fairly steady since.

As you are very well aware, water is a major limiting resource in the Southwest. During the 1940 studies the techniques for quantifying the relationship between plant growth and water use and the relationship between plant water stress and plant growth and rubber production were not available at that time. These techniques are available today. Similarly, we have techniques available today for relating the rate of water used to the various climatic parameters.

Because there was a gap in the old data, we focused our early short-term work in this area of activity. The objectives of our current work as listed in the written testimony concern the areas, as Dr. Grogan mentioned, using bioregulators to enhance the yield and the quality of rubber; determining the soil water regimes and irrigation practices to maximize the production of rubber per unit of water as well, of course, as the economic aspects.

An important component is developing the water use and climatic relationships, which we can incorporate into models for predicting the production capabilities in different areas.

We also have studies under way evaluating the salt tolerance of guayule lines in the southern California area and studies to look at the interaction of salt and other stresses on production.

Because one of the potential areas for guayule production is under dryland conditions, we are developing a cropping system technology for the nonirrigated, cultivated fields in south Texas. We are concerned here with seedling establishment in what is basically considered as rangeland areas at the present time. We have worked cooperatively with all of the researchers involved in identifying or developing a standard analytical procedure so that the rubber analyses that are reported will be comparable from one area to the other.

The results of our research are summarized in detail in the testimony. I feel we have made good progress. We have excellent coop-

eration with each of the four States. This is probably one of the unusual crops in which I think every one of the researchers involved in both USDA and in each of the four States meet at least once a year, and they have been doing that for several years.

We feel we have made good progress in that we have developed a plant growth model using modern computer technology. We have adapted the latest technology in dealing with small seed crops to guayule. We have good, basic studies on the formation of rubber within the plant and, as I mentioned, we have evaluated and have developed standard procedures for rubber analyses.

At our Peoria laboratory we are looking at the processing of the guayule plant, particularly the use of a new supercritical carbon dioxide solvent for extracting rubber and resins.

Dr. Bentley, this concludes my statement.

Dr. BENTLEY. Thank you.

As I have indicated, we have submitted a statement which gives the detailed information.

[The prepared statement of Dr. Bentley follows:]

Statement of Dr. Orville G. Bentley, Assistant Secretary, Science and Education, U.S. Department of Agriculture

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE, I AM DR. ORVILLE G. BENTLEY, ASSISTANT SECRETARY, SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE. I APPRECIATE THE OPPORTUNITY TO APPEAR BEFORE YOU TODAY REGARDING THE NATIVE LATEX COMMERCIALIZATION AND ECONOMIC DEVELOPMENT ACT OF 1978, P.L. 95-592, CONCERNING WORK ACCOMPLISHED UNDER THE ACT.

SINCE PASSAGE OF THE ACT IN 1978, SIGNIFICANT PROGRESS HAS BEEN MADE TO DETERMINE THE ECONOMIC FEASIBILITY OF DOMESTICALLY PRODUCING NATURAL RUBBER FROM GUAYULE. I WOULD LIKE TO EMPHASIZE TO THE COMMITTEE THAT WHILE PROGRESS HAS BEEN MADE THERE ARE STILL MANY QUESTIONS TO BE ANSWERED BEFORE NATURAL RUBBER PRODUCTION CAN ENTER THE ECONOMY OF THIS COUNTRY. OVER THE YEARS THERE HAS BEEN MUCH DEBATE ABOUT DOMESTICALLY PRODUCED NATURAL RUBBER FROM GUAYULE. WE DO FEEL THE NEED FOR CONTINUED RESEARCH IN ORDER TO DETERMINE, ONCE AND FOR ALL, THE POTENTIAL OF GUAYULE NATURAL RUBBER.

IN OUR TESTIMONY WE WILL DESCRIBE THE RESEARCH AND DEVELOPMENT ACTIVITIES CONDUCTED UNDER THE ACT. THIS WILL INCLUDE THE PRESENT STATUS OF RESEARCH AND WHAT CAN REASONABLY BE EXPECTED WHEN THE RESEARCH PROJECTS ARE COMPLETED. THE ACT DIRECTED THAT A NUMBER OF ACTIVITIES BE CONDUCTED AND IT IS CLEAR THAT A GREAT DEAL OF WORK HAS BEEN INITIATED IN EVERY AREA EXCEPT ONE. THIS IS THE ESTABLISHMENT OF A CENTRAL BANK OF RESEARCH INFORMATION AND DATA WHICH CAN BE ACCOMPLISHED THROUGH OUR ONGOING RESEARCH INFORMATION DISTRIBUTION SYSTEM OF THE NATIONAL AGRICULTURAL LIBRARY OF THE DEPARTMENT OF AGRICULTURE.

AS CHAIRMAN OF THE JOINT GUAYULE COMMISSION, I CAN REPORT THE DEPARTMENTS HAVE WORKED CLOSELY TO COORDINATE THEIR ACTIVITIES. THE OTHER MEMBERS OF THE COMMISSION HAVE PREPARED TESTIMONY PERTAINING TO THEIR WORK AND WILL REPORT THE PROGRESS MADE SINCE PASSAGE OF THE ACT.

IMPLEMENTATION OF THE ACT

ADMINISTRATIVE ORGANIZATION

THE DEPARTMENTS OF AGRICULTURE AND COMMERCE HAVE TAKEN LEAD RESPONSIBILITY FOR CARRYING OUT THE PROVISIONS OF THE ACT. THE NATIONAL SCIENCE FOUNDATION AND THE DEPARTMENT OF INTERIOR'S BUREAU OF INDIAN AFFAIRS HAVE SUPPORTED THE WORK OF THE JOINT COMMISSION. THE ACT STATES THAT THE CHAIR OF THE COMMISSION WILL ROTATE EVERY TWO YEARS. BY MUTUAL AGREEMENT, BETWEEN AGRICULTURE AND COMMERCE, CHAIRMANSHIP HAS REMAINED IN AGRICULTURE BECAUSE MOST OF THE WORK HAS BEEN AGRONOMIC IN NATURE.

THE DEPARTMENTS OF STATE, ENERGY, DEFENSE, AND THE FEDERAL EMERGENCY MANAGEMENT AGENCY WORK CLOSELY WITH THE COMMISSION. WITHIN AGRICULTURE, THE COOPERATIVE STATE RESEARCH SERVICE, AGRICULTURAL RESEARCH SERVICE, OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT, SOIL CONSERVATION SERVICE, AND THE FARMERS HOME ADMINISTRATION HAVE SUPPORTED THIS DOMESTIC AND INTERNATIONAL EFFORT. IN ADDITION, THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE, WITH ITS DEMONSTRATION PROJECTS, HAS WORKED CLOSELY WITH THE JOINT COMMISSION AND THE STATE UNIVERSITIES IN FURTHERING THE DEVELOPMENT OF GUAYULE.

THE COMMISSION HAS ENDEAVORED TO CARRY OUT ITS FUNCTIONS UNDER THE ACT WHICH ARE: DEVELOP A PLAN WHICH ESTABLISHES GOALS, TIMETABLES, AND TASKS; ESTABLISH BROAD POLICY FOR IMPLEMENTING THE PLAN; ESTABLISH CRITERIA FOR EVALUATING AND AWARDING CONTRACTS FOR RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROJECTS; AND ADVISE THE SECRETARIES OF AGRICULTURE AND COMMERCE WITH RESPECT TO EXPENDITURES FOR THE VARIOUS ELEMENTS OF THE OVERALL PLAN OF WORK.

IN ORDER TO ACHIEVE BETTER COORDINATION IN DEALING WITH THE THE COMPLEXITY OF DEVELOPING GUAYULE AS A COMMODITY, LINKAGES HAVE BEEN FORMED WITH THREE GROUPS ESTABLISHED BY THE JOINT COMMISSION. FIRST IS THE REGIONAL STATE LAND-GRANT AND AGRICULTURE RESEARCH COALITION WHICH COORDINATES GUAYULE RESEARCH AT THE REGIONAL AND STATE LEVEL. THE COMMITTEE, REFERRED TO AS THE GUAYULE ADMINISTRATIVE MANAGEMENT COMMITTEE, IS COMPOSED OF FIVE INDIVIDUALS REPRESENTING THE USDA AGRICULTURAL RESEARCH SERVICE AND EXPERIMENT STATIONS IN THE FOUR STATES OF ARIZONA, CALIFORNIA, TEXAS, AND NEW MEXICO. THE COMMITTEE WORKS CLOSELY WITH THE USDA/STATE AGRICULTURAL EXPERIMENT STATION FIELD RESEARCH COORDINATOR. THE CHAIRMAN OF THE COALITION PROVIDES A CONTRIBUTION FROM THE LOCAL LEVEL TO THE PLANNING ACTIVITIES OF THE JOINT COMMISSION STAFF GROUP.

SECOND, THE JOINT COMMISSION ESTABLISHED AN INTERAGENCY PANEL TO COORDINATE RESEARCH ACTIVITIES AMONG ALL AGENCIES INVOLVED IN GUAYULE RESEARCH AND DEVELOPMENT. THE PANEL SERVES AS A FOCAL POINT FOR CONTACT WITH ALL FEDERAL AND STATE AGENCIES INVOLVED IN GUAYULE.

THIRD, WITHIN THE DEPARTMENT OF AGRICULTURE, A SPECIAL PROGRAM FOR STRATEGIC AND ESSENTIAL INDUSTRIAL MATERIALS WAS ESTABLISHED. THE PROGRAM MANAGER FOR THE SPECIAL PROGRAM IS ALSO EXECUTIVE SECRETARY TO THE JOINT COMMISSION AND COORDINATES THE WORK OF THE COMMISSION STAFF GROUP. COMBINING THESE RESPONSIBILITIES HAS FOCUSED ATTENTION ON USDA'S NATURAL RUBBER PROGRAM, IMPROVED THE COORDINATION OF THE RESEARCH EFFORTS OF ALL THE AGENCIES INVOLVED, AND ENHANCED COMMUNICATION WITH THE STATE LAND-GRANT UNIVERSITIES AND THE REGIONAL COALITION.

CURRENT SUPPORT LEVEL

I WILL NOW DESCRIBE WHERE THE EFFORTS HAVE BEEN DIRECTED AND THE RESOURCES ALLOCATED TO NATURAL RUBBER DEVELOPMENT. TO SUPPORT THIS TESTIMONY, A COPY OF THE SECOND REPORT TO THE CONGRESS, FROM THE JOINT COMMISSION ON GUAYULE RESEARCH AND COMMERCIALIZATION, IS BEING PROVIDED TO THE COMMITTEE. THIS REPORT, SENT TO THE CONGRESS ON DECEMBER 13, 1982, IS A COMBINED REPORT FOR THE YEARS 1980 AND 1981 AND REFLECTS THE PROGRESS OF ALL RESEARCH AND DEVELOPMENT EFFORTS SINCE PASSAGE OF THE ACT. DURING THIS PERIOD, RESEARCH FUNDING OF THE MEMBER AGENCIES INCREASED FROM $1.51 MILLION IN FY 1980 to $2.33 MILLION IN FY 1981.

RESEARCH FUNDING IN FY 1982 WAS $2.172 MILLION AND NON-RESEARCH SUPPORT $1.135 MILLION, BRINGING THE TOTAL TO $3.307 MILLION. FUNDS ALLOCATED FOR RESEARCH AND DEVELOPMENT IN FY 1983 TOTALS $2.356 MILLION AND $1.0 MILLION FOR NON-RESEARCH SUPPORT PROVIDING A COMBINED TOTAL OF $3.656 MILLION IN THE GUAYULE PROGRAM. SINCE PASSAGE OF THE ACT SOME $8.377 MILLION HAS BEEN EXPENDED FOR RESEARCH IN THE DEPARTMENTS AND AGENCIES WHO ARE MEMBERS OF THE JOINT COMMISSION.

TO PROVIDE A BROAD PICTURE A CHART IS PROVIDED IN THIS TESTIMONY TO INDICATE THE RESOURCES EXPENDED BY EACH DEPARTMENT OR AGENCY.

Research Funds Expended

Department and Agency	FY 1980	FY 1981	FY 1982	FY 1983	TOTAL
	$000	$000	$000	$000	$000
AGRICULTURE					
ARS	69	1,010	1,050	1,304	3,433
CSRS	650	650	702	702	2,704
COMMERCE	200	250	188	*	638
NATIONAL SCIENCE FOUNDATION	500	320	132	250	1,202
INTERIOR	100	100	100	100	400
TOTAL	1,519	2,330	2,172	2,356	8,377

* No funds allocated at this point

TOTAL, FY 1980 - 1983 $8,377,000

WORK AND ACCOMPLISHMENTS OF THE JOINT COMMISSION

IN 1979, THE JOINT COMMISSION'S REPORT TO CONGRESS OUTLINED A 4-YEAR PLAN FOR GUAYULE RESEARCH AND DEVELOPMENT ACTIVITY AND SET THE STAGE FOR THE MAJOR EFFORTS PURSUED OR STARTED IN 1980. THIS PLAN IS INCLUDED IN APPENDIX 4 OF THE REPORT PRESENTED TO CONGRESS LAST DECEMBER. CURRENT RESEARCH EFFORTS REFLECT THE PRIORITIES OF THIS PLAN OF WORK AND INCLUDE RESEARCH IN THE AREAS OF GENETICS, AGRONOMICS, AND PROCESSING TECHNOLOGY.

WORK INITIATED TO DATE HAS BEEN QUITE BROAD IN SCOPE. THE COMMISSION HAS ATTEMPTED TO GUIDE RESEARCH AND DEVELOPMENT ACTIVITIES BEYOND THE MEMBER DEPARTMENTS AND AGENCIES BY INCLUDING THE DEPARTMENTS OF DEFENSE, STATE, AND THE FEDERAL EMERGENCY MANAGEMENT AGENCY IN THE COMMISSION MEETINGS AND RELATED ACTIVITIES.

INTERNATIONALLY, IT HAS INCLUDED WORK WITH THE REPUBLIC OF MEXICO, THE STATE AND FEDERAL GOVERNMENTS OF AUSTRALIA, AND AT PRESENT THERE ARE DISCUSSIONS WITH SOUTH AFRICA. RESEARCH CONDUCTED AND SCIENTIFIC EXCHANGES WITH OTHER COUNTRIES IS VERY IMPORTANT. THE EXCHANGE OF GERMPLASM AND PRODUCTION TECHNIQUES OF DRY LAND GUAYULE PRODUCTION WILL SIGNIFICANTLY BENEFIT THE U.S. RESEARCH AND DEVELOPMENT EFFORTS.

EACH MEMBER OF THE JOINT COMMISSION HAS TESTIMONY THAT DESCRIBES THE WORK OF ITS DEPARTMENT OR AGENCY. THIS WORK HAS BEEN CLOSELY COORDINATED AND TARGETED TO SPECIFIC RESEARCH NEEDS AS IDENTIFIED IN THE JOINT COMMISSION PLAN OF WORK. THIS COORDINATION HAS BEEN ESSENTIAL IN ORDER TO ELIMINATE DUPLICATION OF EFFORT. WE DO FEEL THAT A GREAT DEAL HAS BEEN ACCOMPLISHED AND THAT RESEARCH RESULTS WILL PROVE TO BE EXTREMELY VALUABLE FOR THE PRIVATE SECTOR WHEN IT INITIATES THE FIRST COMMERCIALIZATION EFFORTS.

THIS CONCLUDES MY TESTIMONY AS CHAIRMAN RELATIVE TO THE JOINT COMMISSION AS A WHOLE. WE WILL NOW REPORT ON GUAYULE RESEARCH AND RELATED WORK IN THE DEPARTMENT OF AGRICULTURE. THERE IS CONSIDERABLY MORE DETAIL IN THE JOINT COMMISSION REPORT TO THE CONGRESS BUT ONLY THE MOST SIGNIFICANT WORK AND RESULTS WILL BE HIGHLIGHTED. AT THE CONCLUSION OF MY REMARKS, I HAVE ASKED MEMBERS OF MY STAFF TO ADDRESS SPECIFIC PORTIONS OF THE TESTIMONY FOR AGRICULTURE IN THAT THEY ARE DIRECTLY INVOLVED WITH RESEARCH AND MANAGEMENT ACTIVITY IN THE DEPARTMENT.

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE, WE SUPPORT NATIVE LATEX DEVELOPMENT TO REDUCE OUR TOTAL DEPENDENCY ON FOREIGN SOURCES. THE ADMINISTRATION DID NOT PROPOSE EXTENDING THE NATIVE LATEX ACT FUNDING AUTHORITIES AS PART OF THE FISCAL YEAR 1984 BUDGET LEGISLATIVE PROGRAM BECAUSE OVERALL BUDGET CONSTRAINTS DID NOT PERMIT A REQUEST FOR FUNDING FISCAL YEAR 1984 NATIVE LATEX ACT GRANTS. WE RECOGNIZE THAT THE ACT HAS ALLOWED CLOSE COORDINATION BETWEEN VARIOUS FEDERAL AND STATE AGENCIES TO FOCUS ON THIS IMPORTANT NATIONAL NEED. HOWEVER, IT IS OUR VIEW THAT THE PRIMARY PURPOSES OF THE ACT AND THE RESPONSIBILITIES OF THE DEPARTMENT OF AGRICULTURE IN FURTHERANCE OF NATIVE LATEX PRODUCTION IN THE UNITED STATES CAN BE ACCOMPLISHED WITHIN EXISTING AUTHORITIES. WE INTEND TO MAINTAIN OUR COMMITMENT TO DETERMINE THE ECONOMIC FEASIBILIYTY OF NATURAL RUBBER PRODUCTION FROM GUAYULE.

THIS CONCLUDES MY PORTION OF WRITTEN TESTIMONY, MR. CHAIRMAN. AT THE CONCLUSION OF MY STAFF'S REMARKS, WE WILL BE PLEASED TO ATTEMPT TO ANSWER ANY QUESTIONS YOU OR MEMBERS OF THE SUBCOMMITTEE MAY HAVE.

WORK AND ACCOMPLISHMENTS OF THE DEPARTMENT OF AGRICULTURE

THE DEPARTMENT OF AGRICULTURE'S ANNUAL RESEARCH EXPENDITURE ON GUAYULE FOR FY 1983 IS $2.006 MILLION. IT IS ESTIMATED THAT ANOTHER $250,000 IS PROVIDED FOR STAFF SUPPORT AND OTHER ACTIVITIES WHICH WOULD BRING THE TOTAL TO SOME $2.25 MILLION DOLLARS. IN ADDITION, THERE ARE OTHER PROJECTS IN AGRICULTURE THAT HAVE BEEN SUPPORTED BY FUNDS NOT APPROPRIATED BY AGRICULTURE. THE FOUNDATION SEED INCREASE PROGRAM AND REGIONAL RESEARCH TRIALS PROGRAM WERE INITIATED BY PASS-THROUGH FUNDS FROM THE DEPARTMENT OF ENERGY. THIS REPRESENTS ANOTHER $350,000.

THE COOPERATIVE STATE RESEARCH SERVICE SPONSORS RESEARCH AT STATE AGRICULTURAL EXPERIMENT STATIONS, AND THE AGRICULTURAL RESEARCH SERVICE CARRIES OUT A GUAYULE PROGRAM AT SEVERAL OF ITS REGIONAL LABORATORIES. THE RESEARCH OF THESE TWO AGENCIES FOCUSES ON THE HIGH-PRIORITY AREAS OF INCREASING RUBBER YIELD FROM GUAYULE, FOUNDATION SEED PRODUCTION, CONTROLLING INSECTS AND DISEASES, AND DETERMINING WATER CONSUMPTION AND SUITABLE AGRONOMIC PRACTICES. THE FULL TECHNICAL REPORTS OF ARS AND CSRS RESEARCH RESULTS ARE CONTAINED IN APPENDIX 6 OF THE COMMISSION'S REPORT TO THE CONGRESS.

A VERY CLOSE WORKING RELATIONSHIP BETWEEN THE RESEARCH STAFFS OF THE STATE EXPERIMENT STATIONS AND THE USRA AGRICULTURAL RESEARCH SERVICE PROVIDES EXCEPTIONAL COORDINATION OF THE GUAYULE EFFORTS IN ARIZONA, TEXAS, CALIFORNIA, NEW MEXICO AND OTHER KEY RESEARCH FACILITIES OF THE DEPARTMENT OF AGRICULTURE. CSRS PARTIALLY FUNDS NINE GUAYULE PROJECTS WITH ADDITIONAL FUNDS BEING PROVIDED BY THE STATES. ARS FULLY FUNDS SIX GUAYULE PROJECTS. IN ADDITION, EACH OF THE FOUR STATES HAS A FOUNDATION SEED INCREASE PROGRAM WITH THE OBJECTIVE OF INCREASING THE SUPPLY OF SEED FROM SELECTED CULTIVARS FOR USE IN COMMERCIALIZATION. THE FOUNDATION SEED INCREASE PROGRAM WILL PROVIDE FOUNDATION SEED TO COMMERCIAL SEED PRODUCERS FOR CERTIFIED SEED PRODUCTION. THIS IS FULLY COORDINATED THROUGH THE INDIVIDUAL STATE CROP IMPROVEMENT ASSOCIATIONS.

THERE ARE TEN REGIONAL UNIFORM GUAYULE RESEARCH TRIALS UNDERWAY IN THE FOUR STATES SUPPORTED EQUALLY BY ARS AND CSRS. THESE REGIONAL TRIALS ARE FOR THE PURPOSE OF TESTING ENVIRONMENTAL ADAPTABILITY TO DETERMINE WHICH OF THE CURRENT CULTIVARS ARE BEST SUITED FOR COMMERCIAL PRODUCTION. THE LONG-RANGE OBJECTIVE IS TO EVALUATE PROMISING PROGENY FROM PUBLIC AND PRIVATE BREEDING EFFORTS.

TO HIGHLIGHT THE SIGNIFICANCE OF GUAYULE RESEARCH IN AGRICULTURE AND PLACE IT IN PERSPECTIVE, A 40-YEAR REVIEW OF GUAYULE RESEARCH WAS CONDUCTED IN 1981. THIS REVIEW MAY BE FOUND IN APPENDIX 7 OF THE REPORT TO CONGRESS AND PROVIDES A VALUABLE RESOURCE TO PUBLIC AND PRIVATE SECTOR SCIENTISTS.

PROGRAMS SUPPORTING RESEARCH

TWO IMPORTANT PROGRAMS THAT SUPPORT RESEARCH IN GUAYULE WERE INITIATED IN 1981. THESE WERE THE FOUNDATION SEED INCREASE PROGRAM AND THE REGIONAL RESEARCH TRIALS AND WERE INITIALLY SUPPORTED THROUGH PASS-THROUGH FUNDS IN THE AMOUNT OF $350,000 FROM THE DEPARTMENT OF ENERGY.

THESE PROGRAMS ARE VERY IMPORTANT TO SUPPORT PLANTINGS FOR CERTIFIED SEED PRODUCTION. AGRICULTURE HAS WORKED WITH THE STATE CROP IMPROVEMENT ASSOCIATIONS TO INSURE THAT ALL REQUIREMENTS WOULD BE MET TO ASSURE THE PRODUCERS AND GROWERS A TRUE PROGENY OF CERTIFIED SEED. THE AGRICULTURAL EXPERIMENT STATIONS OF ARIZONA, CALIFORNIA, TEXAS, AND NEW MEXICO, AND THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE, PLANTED 81 ACRES OF THE SEVEN HIGH RUBBER-YIELDING VARIETIES IN THE SPRING OF 1981. THE FIRST HARVEST OF SEED WAS MADE IN 1982 WITH RESULTS VERY NEAR THE EXPECTED LEVEL OF PRODUCTION.

IN THE NEXT FEW WEEKS THERE WILL BE A JOINT USDA AND STATE RELEASE OF THESE SEVEN VARIETIES AND THEY WILL BE MADE AVAILABLE TO THE PUBLIC FOR PRODUCTION OF CERTIFIED SEED. THE GILA RIVER INDIAN COMMUNITY HAS RECENTLY PURCHASED SEVEN POUNDS OF SEED FOR INCLUSION IN THE DEFENSE DEPARTMENT GUAYULE PROJECT AND PENZOIL HAS PURCHASED ONE POUND FOR RESEARCH PURPOSES.

TO SUPPORT THE PLANT BREEDING AND GENETICS RESEARCH OF THE AGRICULTURAL EXPERIMENT STATIONS, UNDER THE NATIVE LATEX RESEARCH GRANTS, REGIONAL VARIETY RESEARCH TRIALS HAVE BEEN INITIATED. THERE ARE TEN RESEARCH PLOTS, FIVE UNDER ARS AND FIVE UNDER THE STATE EXPERIMENT STATIONS. THE PURPOSE OF THESE TRIALS IS TO EVALUATE THE MOST PROMISING, HIGH-YIELDING GUAYULE VARIETIES, TO DETERMINE THEIR PRODUCTION PERFORMANCE IN DIFFERENT GROWING AREAS AND UNDER VARYING ENVIRONMENTAL CONDITIONS. ALL TRIALS INCLUDE THE CURRENT HIGH RUBBER PRODUCING VARIETIES. AS NEW AND PROMISING VARIETIES ARE DEVELOPED OR SELECTED, THEY ARE ADDED TO THE TRIALS FOR EVALUATION. SEEDS FROM THE TRIAL PLOTS WILL EVENTUALLY BE USED FOR FOUNDATION AND COMMERCIAL SEED PRODUCTION IF THEY ARE SUPERIOR TO PRESENT VARIETIES.

COOPERATIVE STATE RESEARCH SERVICE

THE COOPERATIVE STATE RESEARCH SERVICE MONITORS THE NINE NATIVE LATEX RESEARCH GRANTS, TOTALING $702,000 IN FY 1983, TO THE FOUR STATES WHERE GUAYULE IS GROWN. THESE PROJECTS ARE COVERED IN APPENDIX 8 OF THE REPORT TO CONGRESS. THESE LABORATORY AND FIELD STUDIES ARE PROVIDING KNOWLEDGE AND TECHNOLOGY IN THE FOLLOWING AREAS:

-OPTIMIZATION OF RUBBER PRODUCTION THROUGH PLANT BREEDING AND SELECTION;

-BREEDING FOR INCREASED RUBBER YIELD;

-IMPROVEMENT OF THE ARIZONA GUAYULE GERMPLASM COLLECTION;

-SEED PRODUCTION PRACTICES FOR COMMERCIALIZATION;

-WATER USE AND PRODUCTION PRACTICES;

-MANAGEMENT PRACTICES FOR GROWING IN GYPSENOUS SALINE WATER;

-IDENTIFICATION AND CONTROL OF DISEASES;

-STAND ESTABLISHMENT AND CULTIVATION PRACTICES IN WEST TEXAS;

-INFLUENCE OF STAND ESTABLISHMENT METHODS AND HERBICIDES ON RUBBER PRODUCTION.

RESEARCH RESULT FROM THE NATIVE LATEX GRANTS

THE MAJOR EMPHASIS IN THE GUAYULE PROGRAM AT THE UNIVERSITY OF ARIZONA HAS BEEN THE EVALUATION OF EXISTING GERMPLASM FOR RUBBER YIELD AND THE EFFECT OF IRRIGATION REGIMES, VARIETIES, PLANT SPACINGS, PLANTING DATES, AND CLIPPING ON RUBBER PRODUCTION. RESEARCHERS AT ARIZONA HAVE SAMPLED WET, MEDIUM, DRY, AND VERY DRY IRRIGATION REGIMES AND COMPLETED A RUBBER ANALYSIS ON ONE YEAR OLD PLANTS. DRY IRRIGATION PRODUCED THE HIGHEST PERCENT OF RUBBER PER PLANT. CYTOLOGICAL STUDIES OF THE ROLLINS COLLECTION OF GUAYULE GERMPLASM HAVE BEEN INITIATED TO HELP FACILITATE THE GENETIC AND BREEDING PROGRAMS.

THE UNIVERSITY OF CALIFORNIA AT RIVERSIDE IS CONDUCTING THE ANALYSIS OF GERMPLASM FOR RUBBER YIELD. SEED HAS BEEN COLLECTED FROM THE 200 BEST USDA PLANTS AND PROGENY FROM MANY OF THESE PLANTS ARE NOW GROWING IN THE NURSERY. SIGNIFICANT PROGRESS HAS BEEN MADE IN ROOTING GUAYULE SEMI-HARDWOOD CUTTINGS IN BOTTOM-HEATED MISTING CHAMBERS IN AN OUTDOOR NURSERY. THE DEVELOPMENT OF THIS PROCEDURE IS OF GREAT IMPORTANCE IN PROPAGATING NEW CULTIVARS. PROGRESS HAS ALSO BEEN MADE IN IMPROVING RUBBER YIELD THROUGH APPLICATION OF BIOREGULATORS, BREEDING HYBRIDS, AND TESTING THEM FOR YIELD AND VIGOR. SCIENTISTS OF THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE ARE EVALUATING 3,000 HYBRID PLANTS TO USE IN A RECURRENT SELECTION PROGRAM FOR ACCUMULATING GENES FOR HIGH RUBBER PRODUCTION.

RECENT PLANT BREEDING WORK IN CALIFORNIA HAS PROVIDED A NEW SELECTION POTENTIALLY CAPABLE OF PRODUCING 60 PERCENT MORE RUBBER THAN THE BEST HIGH RUBBER PRODUCING VARIETY OF THE USDA LINES. THIS IS HIGHLY PROMISING BUT MUST BE VIEWED WITH MUCH CAUTION UNTIL THIS NEW SELECTION CAN BE EVALUATED FOR AT LEAST THREE YEARS AND COMPARED IN THE REGIONAL RESEARCH TRIALS.

RUBBER YIELDS ARE BEING SAMPLED AT NEW MEXICO STATE UNIVERSITY TO COMPARE THE PRODUCTION OF GUAYULE ESTABLISHED BY DIRECT SEEDING VERSUS TRANSPLANTING. EXPERIMENTS ON HERBICIDE USE ON GUAYULE TRANSPLANTS HAVE DEMONSTRATED THAT, UNLESS HERBICIDES REDUCE THE STAND ITSELF, SHRUB AND RUBBER PRODUCTION ARE UNAFFECTED BY HERBICIDE TREATMENTS. STUDIES ARE UNDERWAY TO DETERMINE IF PLANT-PARASITIC NEMATODES POSE A THREAT TO GUAYULE PRODUCTION.

AT THE TEXAS A&M RESEARCH STATION AT EL PASO, FOURTEEN USDA GUAYULE CULTIVARS HAVE BEEN ANALYZED FOR RUBBER CONTENT AFTER FOURTEEN MONTHS OF GROWTH. THREE CULTIVARS HAVE BEEN FOUND TO BE SUPERIOR IN RUBBER. PREGERMINATION TESTS TO CONTROL RATE OF GERMINATION HAVE BEEN CONDUCTED. EXPERIMENTS ON SALT TOLERANCE LEVELS AND THE EFFECTS OF GYPSENOUS SALINE IRRIGATION WATER ON SEVERAL GUAYULE VARIETIES ARE ALSO BEING CONDUCTED.

AGRICULTURAL RESEARCH SERVICE

THE AGRICULTURAL RESEARCH SERVICE EXPANDED ITS RESEARCH EFFORTS IN 1981 TO $1,010,000. THIS HAS INCREASED TO $1,304,000 IN FY 1983. CONSIDERABLE DETAIL IS PROVIDED IN APPENDIX 10 OF THE REPORT TO CONGRESS. THE FOCUS OF ARS STUDIES IS ON THE FOLLOWING HIGH-PRIORITY AREAS:

-USING BIOREGULATOR TO STIMULATE YIELD AND QUALITY OF RUBBER;

-DETERMINING SOIL WATER REGIMES AND IRRIGATION PRACTICES TO MAXIMIZE RUBBER PRODUCTION;

-DEVELOPING WATER USE AND CLIMATE RELATIONSHIPS FOR PREDICTING WATER REQUIREMENTS AND SCHEDULING IRRIGATIONS;

-DEVELOPING SALT TOLERANCE IN GUAYULE AND UNDERSTANDING THE INTERACTIVE EFFECTS OF SALT AND OTHER STRESSES ON PRODUCTION;

-DEVELOPING CROPPING SYSTEM TECHNOLOGY FOR NONIRRIGATED CULTIVATED FIELDS AND SEEDLING ESTABLISHMENT TECHNOLOGY FOR RANGELANDS; AND DEVELOPING

-STANDARD ANALYTICAL METHODS TO MEASURE RUBBER QUANTITY AND QUALITY.

AGRICULTURAL RESEARCH SERVICE RESEARCH RESULTS

AT PHOENIX, ARIZONA, A COMPUTER MODEL HAS BEEN DEVELOPED FOR PREDICTING BIOMASS AND RUBBER YIELD USING CLIMATE, SOIL, AND PLANT PARAMETERS. AT BELTSVILLE, THE LATEST SMALL SEED TREATMENT TECHNOLOGY HAS BEEN ADAPTED TO GUAYULE SEED WHICH GREATLY IMPROVES ITS GERMINATION SO THAT STANDS CAN BE ESTABLISHED BY DIRECT SEEDING INSTEAD OF BY TRANSPLANTING WHICH WILL GREATLY LOWER PRODUCTION COST.

BASIC STUDIES ON THE FORMATION OF RUBBER IN GUAYULE AND THE EFFECTS OF BIO-REGULATORS FOR INCREASING BOTH RUBBER CONTENT AND RUBBER PRODUCED PER ACRE ARE BEING EVALUATED AT PASADENA, CALIFORNIA. AT RIVERSIDE (BRAWLEY), CALIFORNIA, THE SALT TOLERANCE OF THE AVAILABLE GUAYULE LINES ALONG WITH THE INTERACTION OF PLANT DENSITY AND SALINITY ON RUBBER PRODUCTION ARE BEING EVALUATED.

A STANDARD METHOD IS BEING DEVELOPED FOR MEASURING THE RUBBER QUANTITY IN GUAYULE THAT WILL ENABLE RELIABLE COMPARISONS OF RUBBER. A NEW SUPER-CRITICAL CARBON DIOXIDE SOLVENT EXTRACTION PROCESS FOR EXTRACTING RUBBER AND RESINS FROM THE GUAYULE SHRUB IS BEING DEVELOPED AT PEORIA, ILLINOIS. A LABORATORY SCALE SOLVENT EXTRACTION PROCESS HAS BEEN DEVELOPED AND SUCCESSFULLY TESTED. BOTH MEXICAN AND U.S. GUAYULE LINES WITH AND WITHOUT BIOREGULATORS FOR PRODUCING GUAYULE UNDER NON-IRRIGATED RANGELAND CONDITIONS IS BEING EXPLORED IN TEXAS. INITIAL RESULTS OF THESE STUDIES INDICATE THAT NATIVE PLANTS APPEAR TO GROW FASTER THAN IMPROVED CULTIVARS. RESEARCH IS HELPING TO DETERMINE THE OPTIMUM TRANSPLANTING TIMES, PLANT POPULATIONS AND POSSIBLE INTERCROPPING FOR NON-IRRIGATED CONDITIONS IN TEXAS. ARS IS COOPERATING WITH THE FOUR SOUTHWEST STATES TO INCREASE SEED FROM THE ORIGINAL GERMPLASM LINES STORED AT THE NATIONAL SEED STORAGE LABORATORY AT THE CONCLUSION OF THE USDA GUAYULE BREEDING PROGRAM IN 1959.

Dr. BENTLEY. There has been an annual report to Congress covering 2 years of the work. We have gone over some of the highlights of it.

I believe this completes our comments this morning other than for me to say once more that in working in the Joint Commission we are striving to carry out our interdepartmental responsibilities as well as coordination within Agriculture. I am sure that as the other witnesses come forward they will speak about the activities in other departments of the Government that are participating under the Native Latex Act.

Thank you. We would be pleased to answer any questions that you might have.

Mr. BROWN. Thank you very much, Dr. Bentley. I think you and your colleagues have given us a good picture of a program in which reasonable progress is being made and more can be hoped for in the future. I think that is the picture that we wanted to get.

Before opening it up for questions, let me just recount a little history to you in light of your opening statement that you feel this is a good program but the administration is not asking for extension of the authorization nor is it asking for the line item funds. The administration feels that this program can be carried on within your existing authority and without separately identified funds.

Guayule is a very old plant. The rubber from guayule was used by the Indians when Cortez first came over here. It was the major source of commercial rubber during the early part of this century for both Mexico and the United States. It was rediscovered by Eisenhower in the thirties, who recommended that we develop the industry because he did not want us to be dependent upon imported rubber. We authorized the emergency rubber project in World War II to follow through on that, when our rubber supplies were cut off. The first crop was ready to be harvested when the war ended. By that time, we had a synthetic rubber industry and imports were coming back in, so we plowed up all that and did not take advantage of any of the research.

When I was elected to Congress 20 years ago, I went over to the Department and asked if there was anything we could do to develop the guayule industry or was there any further work needed. I do not imagine any of you gentlemen were part of that conversation, but I was told that the Department of Agriculture knew all there was to know about guayule, and we did not need a program. Of course, I was not on the Agriculture Committee at that time, but I talked to Mr. Pogue, who was, and I knew of his interest. Lo and behold, 10 years later I got on the Agriculture Committee, and there still was not a guayule program and I was told by the Department if I wanted one, we would have to get the Congress to authorize it. We got the Congress to authorize it five years ago. The program was authorized at a rather substantial level, as a matter of fact, $5 or $10 million a year. The framework which you have described for coordination was a part of that.

Now you come back to me 5 years later and you say:

We still don't need a framework. We are doing everything that needs to be done. In effect, we know better than the Congress knows about what the welfare of the

country demands in terms of strategic materials and how fast to go about getting them.

Now I do not blame any of this on any of you. Please believe me. I am just recounting this as bureaucratic history. It helps to influence my thinking about whether to believe you when you say you do not need an authorization program.

With that brief diatribe, I will recognize Mr. Walgren for any questions he may have.

Mr. WALGREN. Thank you, Mr. Chairman.

To go on a little bit different track than the chairman has started out with, can you tell us anything about the ability to generalize from this research project to other agricultural-scientific breakthroughs? It strikes me that in the process of the various research programs you really are touching on very basic agricultural concepts that do have tremendous potential, even extending on into the computer evaluation.

There has to be some very real value in having that kind of effort go on. What can you tell us about that?

Dr. BENTLEY. I will respond, and perhaps others will add to it.

I do think that the manner in which this work is being carried is a good example of how we can and should conduct research, especially that concerning development for crops, livestock, fiber crops, whatever it is, that will affect a region.

In this connection I might add that the 1981 Farm Act calls for an assessment report on the status of food and agricultural sciences in this country, along with a 5-year projection on needs. That was identified by your colleague as one of the areas that should be given attention. I agree with him very much. This is an important thing.

In the process which is under way right now, we are spending a great deal of time talking with all of the participants in the agricultural research, extension, and teaching programs in the public side in developing a report and looking at places where we can cooperate more, where greater interaction and more joint activities can be undertaken.

Moreover, we are talking with industry to see where linkages can be made. I refer to this because it in part answers the question you have raised concerning the mode in which the research should be conducted.

We have been doing this in agriculture for a long time through our system, but as problems become more difficult and more challenging, we need to look at new ways for interaction and for joint effort. We think that this is the way of the future as far as our publicly supported research is concerned, whether it is at the State level or at the Federal level.

In this particular activity we have planned a program and we are moving ahead with its implementation.

Mr. WALGREN. Would any of the other gentlemen like to give us a feel of the relationship of this program to basic research that would be applicable either directly or through the skills of the institutions that are developed or the people that are in place to other areas?

Dr. WHEATON. Mr. Walgren, I would like to respond just briefly on that.

Traditionally, we have become accustomed to certain crops producing food and fiber for human consumption. Those crops that we see growing in specific areas form the economic base of these areas. The farmer and supporting industries rely heavily on these commodities and tend to resist changes for new crop introduction.

When you begin to introduce a new commodity such as guayule, which is not a traditional food-and-fiber type of crop, it takes some special efforts to begin to bring that commodity into the infrastructure and the existing economic base. It is somewhat foreign to those growers who grow corn, wheat, cattle, hogs, and other types of commodities.

What we are learning, at least from my standpoint of working with this now for about 3 years, is that you have to make things happen to bring a new crop into the infrastructure. You have to introduce it into the university research system. You have to begin to educate people who will eventually grow this commodity.

Mr. Brown, you mentioned that guayule has been around a very long time. It took a great deal of time for soybeans and sunflowers and others to develop as a new crop.

I think what we are learning on how to bring a new commodity on liné has been extremely valuable. A concentrated effort and considerable coordination is required to start a new commodity. We have worked on guayule for 4 years under the Native Latex Act and previously in World War II, but this is still a new commodity and foreign to traditional farming. Perhaps we are learning, in my view, how to bring a new commodity into the mainstream, into the economy, into the structure.

Mr. WALGREN. Can anybody speak to the effort to advance the scientific knowledge of the mechanism of this plant? Is a contribution being made in that area?

Dr. JENSEN. Mr. Walgren, as I mentioned briefly before, in the early stages as we have increased our effort on guayule, we probably have been relying more on the transfer of technology and new scientific knowledge in both the plant science area and in the physical science area. We have been transferring that knowledge into our studies dealing with guayule.

Certainly, as new techniques or as new knowledge is developed, as we carry out our detail studies with guayule, that type of information, likewise, will be transferred back or used with other crops. It is kind of a two-way street, but I think during the early stages we have been relying more on the transfer of new science in the biological fields and the physical fields into our studies with guayule.

Mr. WALGREN. Any other responses to that same question?

Dr. GROGAN. I would like to make a few brief comments, Mr. Chairman.

As we look at the recipients of the guayule grants, we have found through this process that there are strengths in each of the institutions that are the recipients of these grants, and that to try to put all of the effort at any one institution would have had, I think, a negative impact from the standpoint of advancing the sciences, but, rather, that we are capturing the strengths in the States of New Mexico, Texas, Arizona, and California in this total effort.

Then we tie in, we come back to tying in the need for new information that through our competitive research grants, basic research, that are part of agriculture, there will be certain applications of that technology that may be applied to guayule as well. As far as advancing science, I think guayule is a good plant that could utilize certain of the technologies that are being developed through basic research as well as practical research at the various institutions and cooperating with the Department of Agriculture and others in this total guayule effort.

Mr. WALGREN. Thank you, Mr. Chairman.

Mr. BROWN. Mr. Roberts.

Mr. ROBERTS. Yes, Mr. Chairman.

First of all, I would like to associate myself with the remarks made by my good friend and colleague and the chairman of this committee. I do not think there is anybody who has been more of a leader in regard to this entire subject area and in behalf of long-term planning and policy. This is a front burner town, as we all know, but it seems to me that this kind of an issue which has been on the back of the back burner could become a front burner issue in the years to come. I would say for the record that the chairman shares the wisdom of General Cortez and also President Eisenhower in the development of this program.

At any rate, I would like to ask a followup question in line with the chairman's remarks. On page 9 of your testimony, Dr. Bentley—and let me say I appreciate your comments and also the contributions made by your colleagues—I beg your pardon, it is on page 7.

You make the statement,

> We support native latex development to reduce our total dependency on foreign sources, but the administration did not propose extending the Native Latex Act funding authorities as part of the Fiscal Year 1984 budget.

If that is the case, how can you accomplish this within the present authorities? It seems to me you are for the program but you do not want the program, or am I reading something into this?

Dr. BENTLEY. Yes. I was really speaking about the line items. What we would do with regard to the special grants that are in the current budget, those were obligated on a continuing basis, so that those projects that were a part of the 1983 budget will be completed. They are 4-year projects. Funds have been obligated to complete the ones that are under way.

Mr. ROBERTS. Therefore, you have about a 4-year pipeline for these projects.

Dr. BENTLEY. Yes. I want to add one part to it. As a part of the new crop development and the continuous research on all kinds of crops with the ARS, we would continue a program at about its current level in ARS because the funds are allocated from the regular budget for that purpose.

Mr. ROBERTS. However, you see no need to go ahead with the current authority in terms of the extension of this act? I just do not understand.

Dr. BENTLEY. The Department of Agriculture is committed to continue within the funds available with the research and work on guayule that we have started. We are going to continue this as long

as as the funds are available, but we are not asking for the special grant funds at this time.

We would do this whether the act is extended or not. We can have the cooperative ventures involving people here on the program that we have talked about. We can continue this kind of cooperative effort under our existing authorities. In fact, we do a lot of this in connection with oat breeding or wheat breeding or other cereal crops and vegetable crops, and so forth.

Mr. ROBERTS. I have every confidence in the Department of Agriculture from the standpoint of your intent and especially in terms of your leadership, but on page 3 here we are talking about the National Science Foundation and Interior and Agriculture and Commerce and State and Energy and Defense and FEMA and virtually everybody working together under the same tent. I am just wondering how would you expect the other agencies to continue work on this project of the act were not reauthorized. Will we be able to continue this kind of interagency work on the project?

Dr. BENTLEY. Let me answer in so far as I can from my own perspective. I believe that effort should be continued to evaluate the potential of this crop. There have been false starts before. I would hope that our Government and the States involved will continue this long enough to know exactly what its potential is and whether or not we can improve the crop, and how it might fit into our production scheme in this country.

Now as far as Agriculture, I have already made a statement there. If the act is not extended, we would hope that we can maintain momentum for the interdepartmental commission, but that would mean, in that case, that some persons representing committees would have to take that initiative to maintain it because we could continue to do it in the absence of the legislation.

On the other hand, the legislation, as the chairman pointed out, has helped bring about the communication and joint planning effort. If it is extended, we would work under that as well.

Mr. ROBERTS. I must confess that I find myself a little confused, I guess. Ninety-five percent of the time I am worried about Federal agencies continuing programs after their authorization or their official capacity has already run out, and I am always complaining about that. In this particular case, I think it should go forward and you say you can do that.

What is the objection to Congress simply reauthorizing this act so as to make certain the project will continue?

Dr. BENTLEY. We have none insofar as I know.

Mr. ROBERTS. Why didn't I ask that first? [Laughter.]

Dr. BENTLEY. It is the prerogative of Congress.

Mr. ROBERTS. Dr. Jensen, from Fort Collins, just to get this cleared up right away, I am looking for an alternate crop in my summer fallow land. There is no way we can grow this in western Kansas, can we?

Dr. JENSEN. Guayule is fairly sensitive to low temperatures, and when you get up near the high plains of Texas you are near the northern border with the present cultivars that we have.

Mr. ROBERTS. I was hoping some of that research would prove that it is becoming a tough, tough plant and we could do that in Kansas.

I have no further questions.

Mr. BROWN. Would the gentleman yield?

Mr. ROBERTS. I would be more than happy to yield to my chairman.

Mr. BROWN. If we put enough emphasis on basic research and genetic manipulation, we can put a gene into the guayule which will allow it to survive in the cold weather, but we have not gotten to that point yet.

Mr. ROBERTS. The gene in that plant over there must have escaped here. It is like the genie in the lamp.

Mr. BROWN. Mr. Skeen, do you have any questions?

Mr. SKEEN. Thank you, Mr. Chairman.

I think what you need as far as Congressman Roberts' area is concerned is a guayule plant that will eat wheat. [Laughter.]

If you fellows can do that, I think we have part of our answer here, because we can make rubber out of the rest of it.

Mr. Chairman, I share your concern about this program. I do not know how long the U.S. Department of Agriculture has been involved as a primary grantor in the production of guayule but possibly just since the Act, and I think it probably had some involvement at the end of World War II. Is that right, Dr. Bentley? In those early days your department did not have just a stray interest in the history of guayule production?

Dr. WHEATON. It ended up in 1952.

Mr. SKEEN. 1952?

Dr. WHEATON. Yes, sir.

Mr. SKEEN. You have been involved steadily since that time?

Dr. WHEATON. No. That is when the program ended after World War II.

Mr. SKEEN. Oh, I see.

Dr. WHEATON. 1952 is when they burned the last fields.

Mr. SKEEN. They burned them?

Dr. WHEATON. Yes, sir. They concluded and stored the seed that they had at that time. They stored the seed, and they concluded the research at that time.

Mr. SKEEN. They did store seed?

Dr. WHEATON. Yes, sir. That is what we are using today in our genetic and plant breeding work, the seed that came out of that, the high-producing varieties.

Mr. SKEEN. Excuse me. I did not mean to interrupt you.

How many years of operation did the USDA have at the end of World War II in guayule production, from when to when, and what part of the forties up to 1952?

Dr. JENSEN. At the end of the emergency rubber project, which was 1946, the guayule work was continued under another program. I do not recall the exact name. We continued the guayule breeding activities until 1959. At that time essentially all guayule work, breeding work particularly, was terminated.

The lines, as Dr. Wheaton mentioned, were saved at the seed storage laboratory. These seeds now have been increased and are being made available now for planting purposes.

Dr. BENTLEY. Someone has indicated to me that they believe the work started in 1942 and perhaps continued——

Mr. SKEEN. 1942.

Dr. BENTLEY. There was some continuation, as Dr. Jensen has said, until 1952.

Mr. SKEEN. My erudite colleague over here has been reading the book and is telling me that if I would just read the history back there—but I have my objectives and he has his.

There is some mention on page 9 that the Gila Indians had purchased 7 pounds. Was this under the grant? Then they had a $20 million grant. There are some real problems in economics there somewhere.

Dr. WHEATON. Mr. Skeen, the Gila River Indian community purchased 7 pounds of seed for, I assume, utilization in the project with the Department of Defense. I think Defense will comment more on that, but they purchased 7 pounds of the varieties that we are increasing now, the high rubber-producing varieties.

Mr. SKEEN. They had a $20 million grant?

Dr. WHEATON. I think Defense will be able to provide this information.

Mr. SKEEN. Is that DOD's grant?

Dr. WHEATON. Yes, sir. They will be able to talk more specifically about this after our testimony.

Mr. SKEEN. Fine.

What I am really getting down to is that we seem to have a problem. I share the chairman's concern that we start these programs, then we kill them off. We have seen this cycle going on in guayule production every time we get tight on petroleum or some of the other petrochemical adjunctives to the rubber industry. The Mexican Government has had the same problem: they have developed their petroleum base, and then they killed off their guayule plants that they had in northern Chihuahua. They still have—and I am sure there is some cooperation going on—they still have a cooperative station just south of Juarez, I believe.

Is that still in operation down there? Dr. Niehaus might know.

Dr. WHEATON. Are you talking about the Mexican pilot plant at Saltillo?

Mr. SKEEN. Saltillo?

Dr. WHEATON. Yes, sir. There is a pilot plant there. They only use it whenever they need the rubber for research at this point. That is our best understanding.

Mr. SKEEN. That is all, but they are not in commercial production.

Dr. WHEATON. They are not in commercial production at this time.

Mr. SKEEN. What I am trying to point out is that something comes along and overshadows a program, then we lose. I think at the U.S. Department of Agriculture you pretty well kept your base and kept building on it.

However, it goes back to this problem: We help initiate at the Federal level research and development, but sometimes we have a tremendous problem being involved in the technological transfer to a marketable product. I understand now that the Firestone plant near Phoenix is about to go down. Is that one using guayule?

Dr. WHEATON. You are referring to a Firestone plant at Phoenix, sir. Firestone does not have a plant at Phoenix. They have a site down at Fort Stockton, Tex.

Mr. SKEEN. At Fort Stockton?

Dr. WHEATON. Yes, sir, that site, the Texas A&M University, Texas Agricultural Experiment Station, is in the process of negotiating a five-year lease for that site now. It has 200 acres of planted guayule, and USDA will work with Texas Agricultural Experiment Station in furthering research on guayule on that 400-acre site. Two hundred acres is in a very good germplasm base. There are several collections in that base, and it is relatively assured, at this point, that we will get that lease signed.

Mr. SKEEN. Therefore, we are not ebbing away from this thing? What I am getting at is actual plant production and the process of making the rubber itself. How do we stand there?

Dr. Bentley, go ahead.

Dr. BENTLEY. That is the reason that there is some work being done at the ARS Northern Regional Research Laboratory at Peoria, Illinois, on two or three fronts. One has to do with how to handle the plant material, because it is bulky and subject to breakage and all of these kinds of things. There are some peculiar characteristics of the latex when the plant parts are broken or shattered. There is also a matter of the way of extracting the material so that you can get standardized procedures and then perhaps set quality standards as well. All of these kinds of things are being investigated on a small, pilot basis—not in a pilot plant but in a laboratory using laboratory techniques, so that they can go ahead and set some guidelines for industry to help industry move into the commercialization of the extraction process.

Mr. SKEEN. Therefore, you still are as a Department involved in the processing technology?

Dr. BENTLEY. Yes.

Mr. SKEEN. Within the Department of Agriculture?

Dr. BENTLEY. Yes; it is in the laboratory at Peoria, Ill., which is one of the laboratories in the Agricultural Research Service.

In connection with some of the questions, I believe this is an important aspect of developing a plant such as guayule and commercializing it, not only get the growth of it and find out those problems, but you have to look at the processing standardization, so that it can be sold.

Mr. SKEEN. I think that is precisely the point we were making. We have difficulties sometimes.

Yes, Dr. Wheaton?

Dr. WHEATON. In addition to the Peoria work on processing extraction—and that is extremely important—the Department of Commerce will also be able to testify to some work that they are doing at Texas A&M University with the Texas Agricultural Engineering Experiment Station on processing and extraction work. There is a sizable project underway.

In addition, we have not completed all the details yet, but we are working with the Department of the Army on another extraction and processing project. We hope it is going to be a small, pilot-type facility. We are working on that. That is related to agriculture and is being handled in Texas as well. We do not have a final agreement today, but we are working on it. We think that, in addition to what we are doing at Peoria, is going to help us bridge right over to industry whenever that time comes.

Mr. SKEEN. I appreciate very much the responses, as I have gained a great deal from them. I will try to go back and read all the documents to become more conversant with them.

I do want to tell you how much we appreciate your being here today. You have mentioned some real fine universities, Texas A&M and New Mexico State University. I appreciate that, too.

Thank you very much, Mr. Chairman.

Mr. BROWN. The only thing that would have made it more interesting is if they could prove that guayule was good to feed the sheep.

Mr. SKEEN. They will eat anything. [Laughter.]

It puts elastic bands in the clothing.

Mr. BROWN. Mr. MacKay.

Mr. MACKAY. Dr. Bentley, I am newly involved in this whole area and I may ask some questions that you have covered or that are very basic. I hope you will be charitable with that.

It would appear to me that you have a project going here which is sort of a pilot project on low-energy agricultural research. Would you see it as having that kind of implication? In other words, if you assume that somewhere down the road American agriculture is going to get into problems because it is high-energy intensive, it seems to me guayule is one specific example of where we have come to the conclusion we cannot afford to be locked into that. It seems to me you are doing a number of items of research in trying to find out how we could move toward lower-energy intensive agriculture. Do you see that as an implication of this?

Dr. BENTLEY. Let me speak in a general way, sir. Yes, because of the flexibility in agriculture and the capacity to change plants one can. We have to have that capacity in this country. You have to have the kinds of plants and systems approach that will accommodate the production patterns that we have.

In the area of low energy it is really utilizing two things in the Southwest for this plant for production. One is less water, although these plants do respond to irrigation and more water, and second using land that probably is not as adaptable to traditional production as we presently practice.

What we are doing is taking the scientific knowledge we have in technology and creating a plant and evaluating plants and seeing whether or not we can improve their capacity to produce the desired end product, in this case latex, and do it on land that is probably marginal for cropping in some cases and with less water. We are likely to be facing more water problems in the next decade than we might be in energy, so it seems to me that is something that we in this country must give a great deal of attention to, and we are already, but we will need to give more attention to it. In that sense, the work with guayule fits into that mold very well.

Mr. MACKAY. What I was going to ask is, what else have you got going that would be within that same parameter? Water, at least in my part of the world, is an energy problem, also. You have to pump it from somewhere, and that is energy.

In other words, if you are the research arm of America in this area, how do you define and how do you see your role in that?

Dr. BENTLEY. You have opened up a very large subject, but let me see if I can illustrate and provide an answer that suggests the direction we are taking.

I think that in much of our research, whether it is with plants, animals, or fruit crops, we are looking at stress, what kind of stress can we put on plants and whether or not we can find ways for a plant or an animal to cope with that stress.

Let's just take plants. We are talking about drought-resistant, drought-tolerant, being able to cope with higher salt content, different temperatures. Reference was made to whether or not guayule could be made adaptable to grow in Kansas. Now it cannot. Even in the Southwest, I understand, the cool nights bother some of the varieties.

If I would answer your question in a generic way, yes, much of what we do deals with coping with stress, whether that stress be brought on because of higher fertilizer prices in the future or less water, more concentrated growth or production practices, as we are using in livestock, in plants, and so on.

I think the answer to your question is, yes, that is a central theme in much of the work we are doing, and it is manifested in many ways. It has application in many aspects of production, food and fiber production.

Mr. MACKAY. What is your budget in Agricultural Research? I know this is also a very basic question.

Dr. BENTLEY. In terms of totals, I do not know if I can give you exact totals right now, but let me use the kinds of working totals that I think of. Our totals for the Agricultural Research Service are about $460 million. That is for the Agricultural Research Service.

In the Cooperative State Research Service budget, which represents the grants to the States, it is $244 million.

That is the total budget that we are working with for Agricultural Research. In addition, of course, there is the extension activities which are so important to technology transfer and education for farmers and producers of all kinds of products as well as consumers and processors.

Mr. MACKAY. The reason I am asking this question is that I serve on Mr. Volkmer's subcommittee which is our space research effort in this country. We have been listening to NASA and others involved in that effort, defining what the goal is, what the problem is, and how they are trying to succeed so we can measure whether we think they are succeeding or not.

Would you give me that kind of definition yourself? I see one of the problems that this country faces is that we are too locked in to high-energy-intensive agriculture and that our research efforts were created to maximize production at a time when energy was a relatively minor cost. My criticism would be we are still solving that problem, but we are solving it now in a way that is going to create a different problem.

One of the things that interests me in guayule is an effort to look forward and start solving the next problem. I am saying, what are you doing? Who is doing that kind of thinking, defining what the next generation's problems, and where would I look? If it is not in the USDA, where would I look?

Dr. BENTLEY. We think we are looking at these matters very carefully, and I would hope that in January of 1984 that I will be before some of you telling about the results of an intensive effort we have had, or that is now under way. We will try to evaluate the current state of the needs as far as research and then lay out some general guidelines for how we hope to achieve these or meet these needs as we identify them in the assessment. We will most certainly look at the very types of questions you raise.

In fact, I was at a seminar earlier this week in which our people had brought together representatives from industry, from universities, and our own in-house organizations to talk about these very topics in terms of water, energy, land use. We have a great concern in this country about conserving our natural resource base and also looking at ways that we can cope with disease, plant and animal disease and insect problems, the impact of these practices, production practices, on the environment, and what is likely to occur over a period of time. We hope that we will be addressing those.

I would also say that our colleagues are right now doing that in many places, perhaps not in such a comprehensive way as we hope we will be doing it in this next year.

Finally, the Agricultural Research Service has undertaken a planning study over the past year and has just now released their recommendations on how they think the ARS should look and move ahead in the next 6 years. These are planning efforts that have involved a lot of people. We are talking to scientists, to industry, to marketing organizations, commodity organizations, trying to get the best information we can. We are trying to look at the world food situation and what is the likely role of the United States as an exporter of food and fiber products and trying to draw some conclusions and getting a basis for us to look ahead.

I think this is a very important exercise. I, myself, have committed to do this, to put a great deal of effort in it.

Mr. BROWN. I appreciate the questions of the gentleman from Florida. They are excellent. I want to assure Dr. Bentley that I did not put him up to those questions, but he is exploring the area, as you well know, that is of common interest to both the Science Committee and the Agriculture Committee. I am going to invite him to switch over to the Agriculture Committee before very long.

However, we do have to get along with this hearing.

Mr. Bateman.

Mr. BATEMAN. I do not have any questions.

Mr. BROWN. Mr. Volkmer.

Mr. VOLKMER. I just want to make sure that I am understanding everything that is being said here and to follow along with the gentleman from Florida and the other questions that have been here this morning.

If the Native Latex Act is not reauthorized, are you telling us we will continue to see research and development in the use of guayule?

Dr. BENTLEY. Yes. It is our intention to continue the program that is under way under the Agricultural Research Service. There are some funds being allotted under a general category of new crops exploration and development. We hope to continue this program as long as it is yielding results and it is needed.

In terms of the special grants, if no new funds are made available, they will terminate. Most of them are scheduled for 4 years, and the funds are there to carry them out over that period.

It is my understanding, although you would have to ask the representatives of the National Science Foundation on this point, it is my understanding they would continue some of the programs that they now have.

Mr. VOLKMER. However, we would not see participation by the other agencies, Commerce and the rest of them?

Dr. BENTLEY. I think you should ask them. My feeling would be that we in Agriculture would like to see the interdepartmental activities continued, and we would attempt to. We would invite people to participate because in the Department we are committed to following through within the resources that we have and getting an answer to some of the questions that have been raised.

Mr. VOLKMER. A little loaded question: Undoubtedly, from what you said here today and what you just told me, there is no question in your mind and the people that you are working with on this, that the guayule use for native rubber shows promise for the future?

Dr. BENTLEY. Yes. I will try to summarize this. There are two things that come to mind when you ask that question. No. 1, it does show promise, but almost more important from my point of view is that we have started once more to evaluate the potential of this crop. I think we should stay with it until we get a full appreciation of its potential and get the information we need, so that it would be available as a strategic source of rubber.

Mr. VOLKMER. What are we talking about for total period of evaluation, 3 to 4 additional years?

Dr. BENTLEY. I would like to defer to the scientists that are working with it. At least 3 or 4 years, yes.

Mr. VOLKMER. From some of the things I have read, I can see a minimum of three, I think.

Dr. GROGAN. I think it will be 3 to 4 years, perhaps 4, that we could have the answer to quite a number of the problems, and it would provide us an opportunity to evaluate what we have at the present time and come up with and clarify the potential of certain of these new strains which we have at the present time.

Mr. VOLKMER. I yield back the balance of my time, Mr. Chairman.

Mr. BROWN. Mr. Franklin, I understand you may have some guests in the audience. We would be pleased to have you introduce them.

Mr. FRANKLIN. Thank you very much, Mr. Chairman.

I have no questions of the witnesses, but I would like to welcome to the Agriculture Committee a group of young ladies and gentlemen from my district in Greenville, Miss. They are with Mr. and Mrs. Tony Blanton, their sponsor. They are here participating in a seminar in Washington. They full well realize the importance of agriculture to the Nation, particularly the district that I represent in their home. They have requested to come here and see where we do this work. I welcome them to this committee.

I thank you for the opportunity to allow me to introduce them.

Mr. BROWN. We are very pleased to have this display of interest in the work of the Agriculture Committee. Of course, we think it is healthy for constituents to observe their Congressmen in action from time to time. It keeps him working harder. [Laughter.]

Thank you very much, gentlemen. You have been very helpful and constructive. I apologize for keeping you for such a lengthy period of time. However, as you know, many of the members of the two committees do not have the background that you are in a position to supply, so you have helped to fill that gap for them.

Dr. BENTLEY. Thank you. We would like to call attention to the fact that in our report there is an outline of projected needs and areas of development, a plan over the next 4 years. It is in the document. I believe we have referred to it, but we have not said it specifically.

We thank you for the opportunity to be here this morning.

Mr. BROWN. That shows commendable foresight on your part, to recognize the fact that this committee might not recommend the termination of the program as the administration is recommending. [Laughter.]

Thank you very much, gentlemen.

Our next witness is Mr. Terry Chambers, Special Assistant to the Secretary of the Department of Commerce.

We apologize to Mr. Chambers for keeping him waiting so long, but we are pleased that he could be here this morning.

You may introduce your colleagues, also.

STATEMENT OF TERRY CHAMBERS, SPECIAL ASSISTANT TO THE SECRETARY, DEPARTMENT OF COMMERCE, ACCOMPANIED BY DR. RICHARD WHEATON, EXECUTIVE SECRETARY, JOINT GUAYULE COMMISSION

Mr. CHAMBERS. Thank you very much, Mr. Chairman.

I am Terry Chambers, Special Assistant to the Secretary. With your indulgence, I have asked the Executive Secretary of the Commission to join me here, in that he serves both of our joint interests.

I have prepared an opening statement. I would like to ask that the record be left open. I dictated this and was not able to read it until after I arrived back in town last night, and there are some minor corrections that I would like to be sure to insert.

Mr. BROWN. Without objection, that will be the order, Mr. Chambers.

Mr. CHAMBERS. The Native Latex Commercialization and Economic Development Act states that the Federal cochairman of the Southwest Border Regional Commission and the Federal cochairman of the Four Corners Regional Commission would serve as members of the Joint Commission. This requirement currently has no effect because these two regional commissions, as well as the other six regional commissions, were terminated pursuant to the provisions of Public Law 97-35.

The regional commissions were terminated on enactment of the act, and their activities were brought to an orderly conclusion over the following 12 months. For this termination period, by a presi-

dential recess appointment, I served as the alternate Federal co-chairman of all eight regional commissions.

While, as a result of the termination of the original commissions, the Department of Commerce may no longer have been required to be represented on the Joint Commission, this Department, because of its long involvement in guayule research and development, has maintained an interest in this Joint Commission, and, in my capacity as the special assistant to the Secretary, I have represented the Department.

Although the chairmanship of the Joint Commission was to rotate between Agriculture and the Department of Commerce, by mutual agreement the chairmanship remained with the Department of Agriculture, as being the most knowledgeable and logical Federal agency to coordinate and provide staff support for the guayule R&D program, which, in your opinion, is essentially an agricultural experiment.

I would emphasize that since the creation of the Joint Commission the Department of Commerce role has been one of cooperation and support with minimal financial contribution. Starting with fiscal year 1983, no funds have been included in the President's budget request for the Department of Commerce for its continued participation in guayule R&D. However, one interim grant was made by the Department of Commerce through its Economic Development Administration. This grant was made to insure that the benefits from earlier guayule programs be concluded and to bring the Department of Commerce participation in the Government's program to a more orderly conclusion.

As I have noted, appended to the testimony, which I request appear in full, as you note, is a detailed statement of the Department's involvement in the Government's guayule research and commercialization program. That involvement has focused upon the process development and the use of byproducts.

While I will not take time to read it, I think that after you have examined it you will agree that the Department of Commerce has supported the development of a domestic natural rubber industry through a well-defined program at minimal cost to the taxpayer. Our research program support has been structured to provide the basis for an industry which will ultimately have to compete economically with other crops if it is to attract sufficient private sector investment to become a commercial success.

The Department of Commerce agrees with the Department of Agriculture that the Native Latex Act should not be reauthorized. There seems to be no sound justification to date for continuing the Government's guayule research and commercialization program under the auspices of a Joint Commission. The role and function served by the Joint Commission could be better and less expensively performed by the Department of Agriculture under other existing authorities and as a part of the other existing Department of Agriculture programs.

Mr. Chairman, within my limited technical knowledge, I will try to answer any questions that you may have on behalf of the Department.

[The prepared statement of Mr. Chambers follows:]

TESTIMONY OF TERRY CHAMBERS, SPECIAL ASSISTANT TO THE SECRETARY OF COMMERCE AND MEMBER OF THE JOINT COMMISION ON GUAYULE RESEARCH AND COMMERCIALIZATION

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEES, I AM PLEASED TO BE HERE TO DISCUSS GUAYULE R&D PERFORMED OR SPONSORED BY THE DEPARTMENT OF COMMERCE AND THE DEPARTMENT'S PARTICIPATION ON THE JOINT COMMISSION ON GUAYULE RESEARCH AND COMMERCIALIZATION.

THE NATIVE LATEX COMMERCIALIZATION AND ECONOMIC DEVELOPMENT ACT OF 1978 (P.L. 95-592) REQUIRES THE FEDERAL COCHAIRMAN OF THE SOUTHWEST BORDER REGIONAL COMMISSION AND THE FEDERAL COCHAIRMAN OF THE FOUR CORNERS REGIONAL COMMISSION TO SERVE AS MEMBERS OF THE JOINT COMMISSION ON GUAYULE RESEARCH AND COMMERCIALIZATION. THIS REQUIREMENT CURRENTLY HAS NO EFFECT BECAUSE THOSE TWO REGIONAL COMMISSIONS AS WELL AS THE SIX OTHER REGIONAL COMMISSIONS AND THEIR FEDERAL COCHAIRMEN WERE TERMINATED PURSUANT TO THE PROVISIONS OF P.L. 97-35. THE REGIONAL COMMISSIONS WERE NOT TERMINATED UPON THE ENACTMENT OF P.L. 97-35 ON SEPTEMBER 30, 1981; RATHER THEIR ACTIVITIES WERE BROUGHT TO AN ORDERLY CONCLUSION. FOR THE TERMINATION PERIOD, BY PRESIDENTIAL RECESS APPOINTMENT, I SERVED AS THE ALTERNATE FEDERAL COCHAIRMAN OF THE EIGHT REGIONAL COMMISSIONS.

WHILE AS A RESULT OF THE TERMINATION OF THE REGIONAL COMMISSIONS THE DEPARTMENT MAY NO LONGER HAVE BEEN REQUIRED TO SERVE ON THE JOINT COMMISSION, THE DEPARTMENT, BECAUSE OF ITS LONG INVOLVEMENT IN GUAYULE R&D, HAS MAINTAINED ITS

MEMBERSHIP ON THE JOINT COMMISSION. IN MY CAPACITY AS A SPECIAL ASSISTANT TO THE SECRETARY OF COMMERCE, I REPRESENT THE DEPARTMENT.

ALTHOUGH, THE CHAIRMANSHIP OF THE JOINT COMMISSION UNDER THE PROVISIONS OF THE NATIVE LATEX ACT WAS TO ROTATE TO THE DEPARTMENT OF COMMERCE ON A BIANNUAL BASIS, THROUGH MUTUAL AGREEMENT, THE CHAIRMANSHIP HAS REMAINED WITH THE DEPARTMENT OF AGRICULTURE. AGRICULTURE IS THE MOST KNOWLEDGEABLE AND LOGICAL FEDERAL AGENCY TO COORDINATE AND PROVIDE STAFF SUPPORT FOR THE GUAYULE R&D PROGRAM WHICH IS ESSENTIALLY AN AGRICULTURAL EXPERIMENT.

I WOULD EMPHASIZE THAT SINCE THE CREATION OF THE JOINT COMMISSION, THE DEPARTMENT OF COMMERCE'S ROLE HAS BEEN ONE OF COOPERATION AND SUPPORT WITH A MINIMAL FINANCIAL CONTRIBUTION. STARTING WITH FY 83 NO FUNDS HAVE BEEN INCLUDED IN THE PRESIDENT'S BUDGET REQUEST FOR THE DEPARTMENT FOR ITS CONTINUED PARTICIPATION IN GUAYULE R&D. HOWEVER, ONE INTERIM GRANT IN GUAYULE R&D WAS MADE BY THE DEPARTMENT THROUGH ITS ECONOMIC DEVELOPMENT ADMINISTRATION TO ENSURE THAT BENEFITS FLOW FROM EARLIER GUAYULE PROGRAM GRANTS AND IN ORDER TO BRING THE DEPARTMENT'S PARTICIPATION IN THE GOVERNMENT'S GUAYULE PROGRAM TO AN ORDERLY CONCLUSION.

APPENDED TO MY TESTIMONY, WHICH I REQUEST APPEAR IN FULL IN THE RECORD AS IF READ, IS A DETAILED STATEMENT OF THE DEPARTMENT'S INVOLVEMENT IN THE GOVERNMENT'S GUAYULE RESEARCH AND COMMERCIALIZATION PROGRAM. THAT INVOLVEMENT FOCUSED UPON PROCESS DEVELOPMENT AND USE OF BY-PRODUCTS.

WHILE I WILL NOT TAKE YOUR TIME TO READ IT OUT LOUD, I THINK THAT AFTER YOU HAVE EXAMINED IT, YOU WILL AGREE THAT THE DEPARTMENT OF COMMERCE HAS SUPPORTED THE DEVELOPMENT OF A DOMESTIC NATURAL RUBBER INDUSTRY THROUGH A WELL-DEFINED PROGRAM AT MINIMAL COST TO THE TAXPAYER. OUR RESEARCH PROGRAM HAS BEEN STRUCTURED TO PROVIDE THE BASIS FOR AN INDUSTRY WHICH WILL HAVE TO COMPETE ECONOMICALLY WITH OTHER CROPS IF ITS IS TO ATTRACT SUFFICIENT PRIVATE SECTOR INVESTMENT TO BECOME A COMMERCIAL SUCCESS.

THE DEPARTMENT AGREES WITH THE DEPARTMENT OF AGRICULTURE THAT THE NATIVE LATEX ACT SHOULD NOT BE REAUTHORIZED. THERE IS NO GOOD JUSTIFICATION FOR CONTINUING THE GOVERNMENT'S GUAYULE RESEARCH AND COMMERCIALIZATION PROGRAM UNDER THE NATIVE LATEX ACT OR UNDER THE AUSPICES OF A JOINT COMMISSION. THE ROLE AND FUNCTION SERVED BY THE JOINT COMMISSION COULD BETTER AND LESS EXPENSIVELY BE PERFORMED BY THE DEPARTMENT OF AGRICULTURE UNDER OTHER EXISTING DEPARTMENT OF AGRICULTURE

ENABLING AUTHORITIES AND AS PART OF OTHER EXISTING DEPARTMENT OF AGRICULTURE PROGRAMS.

WITHIN MY LIMITED TECHNICAL KNOWLEDGE, I WILL TRY TO ANSWER ANY QUESTIONS YOU MAY HAVE.

DEPARTMENT OF COMMERCE PARTICIPATION IN THE GOVERNMENT'S GUAYULE RESEARCH AND COMMERCIALIZATION PROGRAM

As a member of the Joint Commisssion on Guayule Research and Commercialization, the Department has worked with member agencies to develop an integrated plan designed to lead to the commercialization of Guayule rubber. This plan was presented in the Joint Commission's December 1982 Report to Congress. This Report, prepared by the Department of Agriculture, gives detailed information on the activities of the Joint Commission and its member agencies during 1980 and 1981.

The Department of Commerce initiated research and development in Guayule prior to enactment of the Native Latex Act and has supported Guayule R&D to the extent permitted by available resources. The Department was one of the first agencies to launch a program in Guayule R&D. Our initial grants to fund Guayule genetic and agronomic research at the University of Arizona and Texas A&M University were instrumental in initiating the Government's Guayule Program.

The Department of Commerce's Guayule R&D Program has been directed towards the development of economically feasible methods of extracting rubber from Guayule shrubs. If an adequate return on investments in Guayule production facilities

is not possible, the private sector will not make the investments required to commercialize the domestic production of rubber from Guayule shrubs.

Table I shows Commerce Guayule funding levels since FY 1977. The Commerce Department has spent or obligated approximately $1 million for Guayule R&D since FY 1977.

The extraction of usable rubber from Guayule shrubs can be accomplished with currently available technology such as that employed by the Mexican plant at Saltillo. Most, if not all, of the Guayule rubber used to manufacture products for testing such as aircraft tires and pads for personnel carriers, was obtained from that plant. hile more product testing is necessary, there is every indication that rubber derived from Guayule by process employed at that plant is adequate to manufacture usuable products.

The development of a commercial Guayule rubber industry in the United States will be based upon specific varieties of cultivated shrubs. There are not enough wild shrubs in the United States, as opposed to Mexico, to produce large quantities of rubber. While availability of large quantities of shrubs was a limiting factor in the past, current seed increase programs and plantings should alleviate this problem in the future.

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The Commerce Research and Commercialization Program focused on the following five highly interrelated areas:

1. The development of low capital costs methods of extracting rubber either by adaptation of available technology (e.g., oil seed extraction) or new technologies (solid phase processing).

2. The identification of by-product components and an assessment of their commecial value.

3. The investigation of harvesting methods and their relationship to process development.

4. The enhancement of rubber value through the creation of speciality polymers.

5. The identification of deleterious resin components and the testing of long-term storage properties of processed rubber for strategic stockpiling purposes.

The following briefly summarizes our activities and the results of those activities in these five areas:

ANALYSIS OF FUNDAMENTAL PROCESSING VARIABLES

Processing variables (e.g., diffusion coefficients) common to all anticipated extraction processes have been analyzed and predictive models were developed to optimize the extraction process based on resin components. Selective deresination of deleterious components based on the results of this work would be more economical than wholesale resin removal.

DEVELOPMENT OF INNOVATIVE PROCESSES

A new technological process has been developed to eliminate wood, dirt and resin from rubber worms. The process uses a solid phase milking operation instead of the traditional liquid phase filtration of a solution of hexane and rubber. Experimental results from using the new process indicate that the resultant rubber would meet the commonly accepted specifications for tire rubber. Investigation of this new processing method is continuing under an interim Department grant. If the number of steps involved in the use of currently available technology can be reduced, lower extraction processing costs would result.

ANALYSIS AND UTILIZATION OF BY-PRODUCTS

Principal resin components were identified for cultivars for which agronomic information was available in an effort to correlate the agronomic variables with by-product quantities. Bagasse, which represents the major woody tissue component by weight, was investigated both for use directly as a fuel and as a feedstock for conversion to ethanol.

Results of resin component identification and market analysis indicate that the most probable resin use is a fuel, blended with No. 2 or No. 6 fuel oil. The market value of resin after manufacture but excluding shipping is estimated to be $0.07/lb in 1982 dollars. This value is much lower than that previously estimated. Obviously, the significantly lower value has an adverse impact on potential processing economics. Conversion of begasse to ethanol was also investigated. Unfortunately, yields were low. In the absence of new technologies, such conversion would not now be economically feasible.

PRE-PROCESSING OF GUAYULE SHRUBS

The economic viability of Guayule rubber depends on the integration of all phases of Guayule rubber production. The method of delivering shrubs to the processing plant and their storage not only affects the pure logistics and costs of material flow but also plant physiological processes as well.

Both wild and cultivated plants are being investigated to determine the effect of milling and storage times on moisture content and rubber yield. Rubber content as a function of chip size and storage time is also being investigated. Experimental results point to the generally recognized problem of using cultivated shrubs -- a lower rubber content than wild shrubs. Transportation costs are lower if the shrubs are transported in a milled state rather than a baled state. In addition, areas further away from the processing plant could be harvested depending upon the relationship between time and maximum rubber yield.

DEGRADATION AND LONG-TERM STORAGE CHARACTERISTICS

Rubber degradation by linoleic acid, a component of Guayule resin and a principal cause of oxydative degradation in Guayule, was investigated and specific chemical mechanisms were postulated. If total resin extraction is not economically feasible because of low by-product credits, deresination of selective components such as linoleic acid might be economically feasible. Accelerated aging to simulate long-term storage was initiated in order to qualify Guayule rubber for strategic stockpiling purposes.

Under an interim grant, the Department of Commerce is supporting an integrated program of agronomics and pilot plant design initiated at the University of Akron and at Texas A&M University in September 1982. The research will:

- Identify processing conditions and equipment for single stage solvent extraction of Guayule rubber.

- Develop pilot plant design specifications and an economic analysis of the process.

- Continue the development of analytical procedures and quality specifications of Guayule rubber and evaluate storage limitations.

- Continue the evaluation of post harvest treatment on rubber quality and recovery.

- Continue the evaluation of innovative processing technologies such as solid phase rubber refining.

- Evaluate the chemical modification of rubber for product enhancement.

The interrelationship of the agronomic and pilot plant design work underway at Akron and Texas A&M is shown in Figure 1. The Texas A&M facility is capable of processing 1/2 ton per eight-hour day. Once the process has been defined, scale up to a demonstration-size plant of 25-50 tons of shrub per day would be feasible.

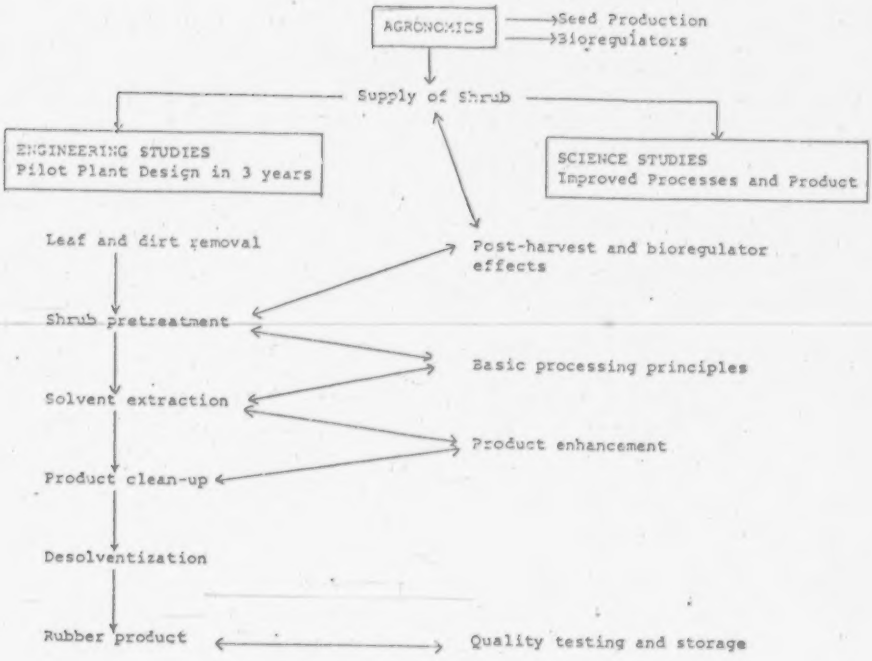
TABLE I

Department of Commerce
Guayule Research and Development Funding

Contractor	Objective	Funding	
Dr. David Rubis University of Arizona	Selection of high quality, high yield plant strains. Weed, insect and disease control. Construction of harvesting equipment.	FY 77	118,975
Dr. Jimmy Tipton Texas A&M	Establishment of experimental plots at El Paso and Pecos, Texas. Development of economical methods for propagation and transplanting of guayule plants into dryland and irrigated sites. Identification of methods for controlling pests.	FY 78	109,496
Dr. David Rubis University of Arizona	Continuation of previous program.	FY 79	85,000
Dr. Jimmy Tipton Texas A&M	Continuation of previous program.	FY 79	61,119
Dr. Donald McIntyre University of Akron Goodyear Tire and Rubber Company	Identification of the principal components of the saponifiable and nonsaponifiable fractions of the resins. Assessment of the potential market values of the total resins or fractions. Determination of the optimum economic use of the nonrubber, nonresinous portions of the plant. Investigation of innovative processing methods at the laboratory level. Characterization and testing of the storage characteristics of guayule rubber for the strategic stockpile.	FY 80	200,000

Contractor	Objective	Funding
Agri Business Research Corporation	Establishment of a workable set of standards and methods for germination, testing, cleaning classification, labeling and packaging of guayule seed. A total of 3,500 lbs. of seed to be delivered by December 31, 1984.	FY 81 250,000
Dr. Donald McIntyre University of Akron Dr. Ed. Lusas Texas A&M University	Identification of processing conditions and equipment for unit operations. Development of pilot plant design specifications and an economic analysis of the process. Evaluation of solid-phase rubber refining and development of models for solid phase processing. Evaluation of chemical modification of rubber for product enhancement. Development of analytical procedures and quality specifications for guayule rubber and evaluation of storage characteristics.	FY 82 188,119

FIGURE I. INTERRELATIONSHIPS BETWEEN THE SEPARATION PROCESSES LABORATORY, THE INSTITUTE OF POLYMER SCIENCE AND THE GUAYULE PRODUCTION PROGRAM.



Mr. BROWN. Thank you very much, Mr. Chambers.

Does Dr. Wheaton care to add anything to this?

Dr. WHEATON. Not at this time, Mr. Chairman.

Mr. BROWN. Mr. Chambers, I don't want to belabor this, but part of the weakness in this program has been what you have alluded to in that the Department of Commerce has not really played the vigorous role that is necessary to insure successful commercialization. I recognize there are problems involved here, and I don't want to belabor them.

It was the thought of this committee in enacting the guayule act that it would be a reasonably short-term, sunset-type operation but one which would provide the groundwork for transitioning this new crop into a commercial operation. This is not something foreign to the Government. We have done a great deal in the Department of Agriculture and in the Government in general to move new crops to the level where there was obvious commercial application and where a market developed and a sufficiently large number of farmers interested in it so that it could become a sound commercial operation.

Obviously, there is no expectation the Government is going to go into the guayule business, but it is also true that for the last 2 or 3 years even the private rubber companies that have an interest in promoting this have been unable to do so because they were failing in their regular rubber business, and they did not have the funds to proceed into a new operation which would only be of benefit 10 or 15 or 20 years down the road.

I would ask you if there is any possibility that the Department of Commerce would change its view on this, but I know what the answer is in advance so I will not even ask that question.

Mr. CHAMBERS. Thank you, Mr. Chairman.

Mr. BROWN. I do want you to know that I think our goals are the same here: to make a rapid transition to a sound commercial operation which the private sector will take over. It is just a question of how we go about achieving it that we differ on.

Mr. CHAMBERS. Mr. Chairman, might I respond with an unasked-for answer?

Mr. BROWN. Certainly.

Mr. CHAMBERS. I do not think that there is any doubt in anyone's mind that I have talked to since I have been rather superficially involved over the past 2 years that there is a future for guayule in the commercialization concept. However, of the many people whom I have talked to and the sites I have visited in traveling around the country, I have come away with a very distinct impression that the Department of Commerce should be extremely careful in encouraging any commercialization process that might put the cart before the horse.

I have not found any agreement among our agricultural counterparts and members of the Commission that even can tell us the form and type of product that we might eventually be working with if we were to develop a commercialized process. That has been the basis of my hesitancy to become too deeply involved until there was a positive direction to what we should be developing.

Mr. BROWN. Maybe I have been talking to the wrong people, Mr. Chambers, but all of the research I have seen indicates that rubber

from the guayule plant is a superior rubber, at least equal to imported, natural rubber from Malasia, and is essential in the manufacture of certain types of automobile tires, racing car tires, aircraft tires.

Mr. CHAMBERS. Mr. Chairman, I evidently did not make myself clear. I am not disputing the fact that the guayule is a superior product. It is how to process the product that was the assignment given to the Department of Commerce. Therefore, we want to be sure that we focus exactly upon the guayule product that might be ultimately produced. I agree with you, sir.

Mr. BROWN. Mr. Roberts, do you have any questions?

Mr. ROBERTS. Speaking as a lay person in this field, I must admit I am even more confused now by your testimony. First of all, I want to thank you for your statement. I have been doing a fast reading course here trying to come up to speed, so please forgive my questions in that I have not done my homework. That has never stopped me from asking any questions.

You stated on page 3, "The Department agrees with the Department of Agriculture that the Native Latex Act should not be reauthorized." Yet, I asked Dr. Bentley if there was any objection to Congress' reauthorizing this act so as to make certain the projects will continue and there would be this continuation of the interagency coordination, and they said no.

I guess I am confused as to where we should be headed. Let me get one thing clear. I was wondering which agency was responsible for the processing technology, and that is the Department of Commerce; is that not correct?

Dr. WHEATON. In the act itself it gave that responsibility to the Department of Commerce.

Mr. ROBERTS. I, then, would ask you the same question. What is your objection to the Congress' reauthorizing this act?

Mr. CHAMBERS. You are asking me for a personal response, and I am caught in the position of being here without the credentials because the act of Congress removed us from it. Therefore, I have been serving sort of as an ad hoc member, passing off the chairmanship back to Agriculture, and feel again as a personal observation, that everything that the act might require could be done through interagency agreement. After close to 20 years in various levels of government, I have yet to see too much real sound end product come out of anything run by a commission.

I think that you must have a positive direction within a single department with the opportunity to go back and forth between other agencies.

Mr. ROBERTS. Congress would continue to work with the Department of Agriculture even though the act were not reauthorized; is that your basis?

Mr. CHAMBERS. I am sure that this would be the position of the Department if asked by the Department of Agriculture to cooperate.

Mr. ROBERTS. Why don't we just consummate the marriage and make it legal instead of living in sin over there with the Department of Agriculture?

Mr. CHAMBERS. Sometimes perhaps the latter is the better choice.

Mr. ROBERTS. I see.

Did I understand you correctly that you did not think there was any product that could be made from this plant that justified the continuation of the grants here that I see?

Mr. CHAMBERS. No, sir, that was not my intent. My concern is there has not been enough product available to warrant the investiture of funds to produce or to actually build a plant. There are several other processes, I believe, under consideration that might allow us to process guayule on existing commercial facilities.

Mr. ROBERTS. Then it would be your view that if there was enough product available that that would justify further effort on the part of the Department of Commerce; is that correct?

Mr. CHAMBERS. It would, again, be a personal observation, but I feel that it would certainly be the Department of Commerce role to encourage free enterprise to take this on. Now whether that would be done through grants—I would hate to leave anyone with the impression that I felt the Department of Commerce should construct and operate any type of mechanical plant, putting them in competition with free enterprise.

Mr. ROBERTS. I thank you for clearing that up. My concern was that the Department of Commerce was putting on the brakes while the Department of Defense was spending $20 million to move ahead, and I could not see that that was a commensurate kind of a policy goal. Therefore, I appreciate your clearing that up.

I have no further questions, Mr. Chairman.

Mr. BROWN. Mr. MacKay.

Mr. MACKAY. I have already stated that I come to this hearing unencumbered by the facts, so I do not feel that I have to make any further disclaimers for asking dumb questions.

Mr. CHAMBERS. I am glad to have a colleague, sir.

Mr. MACKAY. Then together let's explore this question, which seems to me is sort of an underlying question.

On the third page of your testimony you say, "Our research program has been structured to provide the basis for an industry which will have to compete economically with other crops if it is to attract sufficient private sector investment to become a commercial success."

Then, as I understand what you are saying, you have concluded, for one reason or another, that those circumstances do not exist now. I have to ask you, haven't you defined the problem in a way that the only point at which you become interested is if we are in war or if there is a total embargo in the latex-producing countries? In other words, haven't you defined in a way so that you are not going to research it until we have a crisis?

Mr. CHAMBERS. No, sir, that is not what I am attempting to get across.

There are a variety of demonstration plots raising a variety of different types of guayule. The concern that I was expressing was that until we have a determination of what type of crop would be grown in what type of climate, water conditions, or geographic area and then determine what the cost for transporting that crop to a processing plant, and the form in which it would be transported, whether it be shipped baled, pulverized, or whatever the case may be, all enter into the issue of exactly how should the Department of Commerce go into grantsmanship that would create a workable

piece of machinery to process and ultimately merchandize an end product of latex rubber.

My concern is not when we do it but that we must grow the crop and identify what is to be processed before anyone is going to put money into it.

Perhaps, again, I should depend upon the executive secretary of the Commission.

Mr. MACKAY. Since the quality of the product meets the needs of our agencies and meets the needs for stockpiling, it seems to me the thing to do would be to create a market by having Government purchase the product, and then turn it over to the private sector. It seems to me a very constructive way to do this would be to create a market so as to spark people's ingenuity.

It appears to me that what you are saying is (a) we do not want to do that, (b) we do not want to do anything else, and (c) we want to let the act expire and let the USDA continue its enlightened progress since the 18th century, which is nothing.

Mr. CHAMBERS. Let me preempt the microphone back, if I may, sir, for Dr. Wheaton and let you put him on the spot.

At the present time most of the emphasis within Agriculture has been the seed enhancement program and determination of that aspect of it. There has been very limited amount of actual shrub to be processed, and I think that has been one of the major causes of everyone's hesitancy to design equipment. We did, in this past year, come up with a grant with this specific end product, hopefully to justify the investment.

Dr. WHEATON. Mr. MacKay, you are asking some very difficult questions that I do not think I can answer. I think some of those are policy questions that have to be answered by the departments and this administration as well.

To create that market—no one has actually been willing to say we can do that yet.

Let me support some things Mr. Chambers is saying.

To this point, we have had limited acreage of guayule. To this point, there are a number of questions about actually how we want to process guayule. The Mexicans use essentially a crushing and a water floatation and some chemical extraction process. At Peoria, Ill., they are looking at a solvent extraction process similar to soybean oil extraction. They are also working on a critical—if I get the terms right here—a critical temperature or it is a process by which you burst the cells open with subzero temperatures to extract the rubber. Then there is the solvent extraction process which is the use of acetone and hexine.

There is a discussion of another process that uses some similar solvents. We have to answer some of those basic questions about extraction to technology. One of these grants that Commerce has provided is down at Texas A&M University where they are trying to answer some of these specific questions.

Dr. Earl Hammerstrand of Peoria, Ill., is working on some of these very critical questions. We are not ready to go in exactly at this point for processing per se, but we think we are getting close.

Mr. BROWN. Mr. Bateman.

Mr. BATEMAN. Thank you, Mr. Chairman.

I, too, will have to apologize for being abysmally ignorant on the subject of guayule. But, I am sitting here with the luxury of my ignorance, wondering perhaps if part of the problem is that our agronomists are trying to develop the most sophisticated hybrid corn, as an analogy, as the beginning effort to grow the corn on a commercial basis. As opposed to if you have some corn and you have a use for it, you may grow the corn and refine the plant and the hybrid seeds, and so forth, as you move along.

Does that point of view come through to you or make any sense to you?

Mr. CHAMBERS. You are asking me a question outside of my limited knowledge, but in looking around the types of experimental plots that we have, by growing the material available, there seems to be a tremendous effort to develop varieties that will grow in different climates, so that they are not limited to just the strip along the Southwest corridor, as an example.

Being comparatively temperature-sensitive and water-sensitive has, again, led to experimentation in varieties that are not limited to such a narrow band.

Mr. BATEMAN. What comes through to me is that it has been known for some time that you could make rubber products from, for lack of a better term, the juices of this plant. It has been around, growing in its natural state, for as long as anyone knows anything about it. If that be the case, and it has further been demonstrated that the technology to convert the juices of that plant to rubber products has been demonstrated, and the products are equal or superior to the products that emerge from the natural rubber plant, aren't we really awaiting for sufficient supply of the plant, the basic raw material, for someone to be able to justify the capital investment of the plant that would manufacture products from it?

Mr. CHAMBERS. Yes, sir, and I also believe that the factor of the amount of actual latex rubber that comes from that process is going to be hand and glove with the type of plant machinery or process that is designed to make it economically feasible.

At the present time, to the best of my knowledge, there is only one plant in Saltillo that operates on a very intermittent basis to produce rubber. However, being a crop that takes 3 years to grow and then is a seasonal crop, it produces an influx of product, and then has not another thing to do for the rest of the off-season. That also has been one of the efforts, I believe, by the Department of Agriculture, to equalize the product available to be processed.

Mr. BATEMAN. In terms of the processing end of the equation, is the processing technology one that concentrates on the extraction of the critical material from the plant? Once that is done, do you then further process it into the finished product, the same way you would with natural rubber, or is it an entirely different process from the handling of the natural resource to the end product?

Mr. CHAMBERS. I asked that question one day in an open forum and asked what the shelf life of the end product would be, wondering what the deterioration might be, and they referred me back to the process by which it was extracted. Again, quite frankly, I join you in wondering whether this is the chicken or the egg.

I might again get a more technical answer——

Mr. BATEMAN. Let me refine my question a bit further, if I may, Mr. Chairman.

What I am curious to know is this: Assume that I have a lot of the juice from the guayule plant and I can deliver very large quantities of it to a rubber-making factory. Can any rubber-making factory use that material or is the technological dimension that is not thoroughly in place just the method of extracting the material from the plant?

Mr. CHAMBERS. I would defer to the experts that you have on the agenda this afternoon who can answer that question, because I do not have the remotest idea.

Mr. BROWN. Would the gentleman yield to me?

Mr. BATEMAN. Sure.

Mr. BROWN. I am not an expert, but obviously I have been wrestling with this for quite a while. The problem is not quite as simple as your questions might imply, because there is not a juice from this plant. It is not like the rubber tree or maple tree, where you take the sap. What you have to do is cut the whole bush and bring it into the plant. Then you process the whole bush, and the rubber content of that bush is separated out during the processing. In that process there are also certain byproducts of value which can be extracted, resins and so forth. That is not at all like the extraction of rubber from the rubber tree, so it does require the development of a new kind of a processing plant.

They have a pilot plant that does that in Saltillo, Mexico, which, as I understand it, recently has been closed down because they are now becoming more reliant upon their synthetic rubber industry because they have a surplus of oil. That is what happened after World War II in this country. We closed out the guayule because we had a burgeoning new synthetic rubber industry with lots of cheap oil.

Mr. BATEMAN. Mr. Chairman, that was extremely helpful. Thank you.

Mr. BROWN. Thank you.

Mr. CHAMBERS. Mr. Chairman, perhaps Dr. Wheaton also can add briefly to that.

Mr. BROWN. Is somebody going to identify that? Is that a guayule plant down there on the table?

Dr. WHEATON. This, Mr. Chairman, is a guayule plant. It is about 18 months of age. It is a fairly growthy plant for that age, but it suffers from lack of water at this particular moment. [Laughter.]

We thought for those who did not know what the guayule plant looked like, that is a dried-up guayule plant.

Mr. BATEMAN. I will rescue it [holding up his water pitcher].

Dr. WHEATON. It is waiting to be processed.

One of the questions that you had—and whenever we are dealing with the guayule plant, we are dealing with a price structure as well. Guayule rubber, let's take the average price in 1980. It was around 80 cents a pound, New York price. That was the highest price it reached, something like 73.4 cents per pound was the average for that year before the bottom dropped out of this economy that we have.

To grow and process guayule at that particular time was about 83 cents a pound, about a 9.5 cent spread. Industry is not going to

step into anything until they can make a buck. That is just plain economics.

One of the things that we are working on in Agriculture, in our plant breeding work, is to develop some plants that produce more rubber or extract the most rubber that we can out of that plant. Of course, the plant has other value as well. It has resin in it. That is one of the processes in extraction. You do not have to worry about that in hevea rubber because it comes out as a latex and they can dry it out, and it is pretty much ready for processing or compounding.

In guayule you have a two-step process essentially. There are two chemicals. Acetone removes the resin, and you distill that and save your acetone to reuse it again. This is after you have crushed the plant. Then the hexane, which dissolves the rubber, and then you distill the hexane to get the rubber.

Then you can use that resin—I do not have the exact value of that particular product at this point—but when you consider all of those things, you do not have quite the value in guayule to compete with hevea natural rubber.

Then you have the begasse that is left, which is the material that is left after that plant is ground up and the products extracted. That has some value. We do not have a value for that in terms of actual dollar value, but it does have some value. The resin has some value. The rubber has some value. You have to add all these up. We do not have quite all those answers. They are just a bit out in front of us.

Mr. BROWN. Dr. Wheaton, what you have described, though, is the process that the Department of Commerce was presumably to take the lead role in, in determining the economic aspects of this, based on the most reliable figures that could be obtained; is that right?

Dr. WHEATON. Yes, sir.

Mr. BROWN. You have not finished that job yet, according to your answer.

Dr. WHEATON. No, sir. That research project is still continuing at this point.

Mr. CHAMBERS. Which is the purpose of the grant that the Department of Commerce has made.

Mr. BROWN. Have you finished, Mr. Bateman?

Mr. BATEMAN. Yes, Mr. Chairman. Thank you.

Mr. BROWN. Mr. Franklin, do you have any questions?

Mr. FRANKLIN. No, I do not.

Mr. BROWN. Gentlemen, I have a lot more questions but I am not going to ask them right now. I will get back to you later.

Mr. CHAMBERS. Thank you, Mr. Chairman.

Mr. BROWN. Thank you very much.

Our next witness is Mr. Richard Donnelly, Director of the Office of Industrial Resources, Department of Defense.

As has happened so often, we are going to ask the Department of Defense to defend us in this situation.

We are happy to have you here, Mr. Donnelly.

STATEMENT OF RICHARD DONNELLY, DIRECTOR, OFFICE OF INDUSTRIAL RESOURCES, DEPARTMENT OF DEFENSE, ACCOMPANIED BY JOHN ECK

Mr. DONNELLY. Thank you, Mr. Chairman.

Before beginning, I would like to introduce Mr. John Eck, on my right, who is a staff specialist in materials, to help me answer questions.

Mr. BROWN. All right.

The full text of your statement will be put in the record following your oral presentation, if you choose to summarize any part of it.

Mr. DONNELLY. All right, sir. Let me begin and maybe I can summarize as I go along.

I appreciate this opportunity to appear before you in connection with your deliberation on Public Law 95–592. Under this law, the DOD is not tasked with direct responsibilities. Therefore, I will defer to my colleagues in the Commerce and Agriculture Departments for specific recommendations.

As you are aware, the Department of Defense is responsible for maintaining a viable national defense for the United States. To accomplish this, we rely primarily on the private commercial marketplace for development and production of weapon systems and related hardware. Since there is no captive, separate defense industrial establishment, we must assure the continued availability of sufficient raw materials to supply the economy if we are to supply defense, industrial, and civilian needs. For this reason, the reliance of the United States on foreign supplies is an area of concern to Defense.

In many situations we have no alternative but to import basic commodities or raw materials. Our import reliance may be tolerable and cost-effective in peacetime and not disruptive to production, but during surge, mobilization, or a national emergency, the situation may be disruptive and totally unpredictable. To mitigate these potential problems, our policy is to maintain adequate stockpiles unless other alternatives are found to be more cost-effective.

In the case of natural rubber, the Department of Defense has a particular concern. The United States is 100 percent import-dependent on third world nations for supply. Our national stockpile is only 14 percent of the inventory objective.

Further, the national security community utilizes approximately 40 percent of the total imported natural rubber. While it is possible to substitute synthetic rubber in many commercial applications and tolerate performance degradation, this is not acceptable in most defense applications.

For example, our fighter aircraft tires are made of a high percentage of natural rubber in order to meet the performance characteristics which are required to accomplish the mission and insure the safety of the pilot.

For the reasons I have just stated, the Department of Defense actively pursued the development of new methods, techniques, and materials to reduce our reliance on imports in a cost-effective manner while retaining high performance and reliability. Guayule rubber from a North American source has the potential for reduc-

ing the threat to the national security posed by unnecessary reliance on imports.

Therefore, in June of 1977 we tasked our Service Secretaries to evaluate natural guayule rubber as a substitute for imported hevea rubber in military applications. Tests were successfully completed on both new and rebuilt military aircraft tires. In each case test results indicated that guayule rubber performed as good or better than imported hevea rubber. However, after completion of approximately 20 percent of the evaluation program, the only supplier of processed guayule rubber, the Republic of Mexico, discontinued operation of their pilot plant.

Because of the Department's resolve to qualify an alternative to imported hevea and to eliminate, where possible, foreign dependencies, in May of 1982 we initiated a program for establishment of a prototype domestic guayule rubber industry. The program includes guayule crop establishment and maintenance, processing technique development, and facility construction and demonstration.

A contract to commence this effort was awarded in September 1982, utilizing a $20 million loan guarantee under the authority of title III of the Defense Production Act.

Mr. Chairman, if I may parenthetically just mention this to you, I am sure you are aware that the Defense Production Act of 1950 expires the end of this month, March 36. The Department of Defense strongly supports a 5-year extension to the Defense Production Act without revision.

As Mr. Skeen mentioned earlier this morning, starting and killing programs tends to add to the instability in U.S. industry. Having an on-again, off-again Defense Production Act could be detrimental as well.

Mr. BROWN. Mr. Donnelly, may I assure you that if that act were under the jurisdiction of the Agriculture Committee, we would report it out favorably immediately.

Mr. DONNELLY. Thank you, sir. I am very pleased to hear that. I must plead guilty to just trying to approach anyone I can find, whether they are on a committee or off a committee, to explain how import the act is.

Mr. BROWN. We will do what we can to get it extended.

Mr. DONNELLY. Returning to my testimony, on completion of this contract, we expect successful testing and economic evaluation that will demonstrate to the commercial sector the need for a domestic guayule industry.

This concludes my statement. I would be happy to answer any questions the committees may have.

[The prepared statement of Mr. Donnelly follows:]

STATEMENT OF MR. RICHARD E. DONNELLY
DIRECTOR, INDUSTRIAL RESOURCES,
OFFICE OF THE UNDER SECRETARY OF DEFENSE
FOR RESEARCH AND ENGINEERING
BEFORE THE
HOUSE COMMITTEE ON AGRICULTURE
AND THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
MARCH 24, 1983

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEES, I APPRECIATE THIS OPPORTUNITY TO APPEAR BEFORE YOU IN CONNECTION WITH YOUR DELIBERATION OF PUBLIC LAW 95-592, "NATIVE LATEX COMMERCIALIZATION AND ECONOMIC DEVELOPMENT ACT OF 1978."

UNDER THIS LAW, THE DEPARTMENT OF DEFENSE IS NOT TASKED WITH DIRECT RESPONSIBILITIES; THEREFORE I WILL DEFER TO MY COLLEAGUES IN THE DEPARTMENTS OF COMMERCE AND AGRICULTURE FOR SPECIFIC RECOMMENDATIONS ON AMENDMENTS OR EXTENSION OF THE ACT AND WILL CONFINE MY REMARKS TO WHAT OUR OBJECTIVES AND ACCOMPLISHMENTS HAVE BEEN IN THE GUAYULE PROGRAM.

AS YOU ARE AWARE, THE DEPARTMENT OF DEFENSE IS RESPONSIBLE FOR MAINTAINING A VIABLE NATIONAL DEFENSE FOR THE UNITED STATES. TO ACCOMPLISH THIS WE RELY PRIMARILY ON THE PRIVATE, COMMERCIAL MARKETPLACE FOR DEVELOPMENT AND PRODUCTION OF WEAPONS SYSTEMS AND RELATED HARDWARE. SINCE THERE IS NO CAPTIVE DEFENSE INDUSTRIAL ESTABLISHMENT, WE MUST ASSURE THE CONTINUED AVAILABILITY OF SUFFICIENT RAW MATERIALS TO SUPPLY THE ECONOMY

IF WE ARE TO SUPPLY DEFENSE INDUSTRIAL AND CIVILIAN NEEDS. FOR THIS REASON, THE RELIANCE OF THE UNITED STATES ON FOREIGN SUPPLIES IS AN AREA OF CONCERN TO DEFENSE.

IN MANY SITUATIONS WE HAVE NO ALTERNATIVE BUT TO IMPORT BASIC COMMODITIES OR RAW MATERIALS. OUR IMPORT RELIANCE MAY BE TOLERABLE AND COST EFFECTIVE IN PEACETIME AND NOT DISRUPTIVE TO PRODUCTION, BUT DURING SURGE, MOBILIZATION OR A NATIONAL EMERGENCY THE SITUATION MAY BE DISRUPTIVE AND TOTALLY UNPREDICTABLE. TO MITIGATE THESE POTENTIAL PROBLEMS, OUR POLICY IS TO MAINTAIN ADEQUATE STOCKPILES UNLESS OTHER ALTERNATIVES ARE FOUND TO BE MORE COST EFFECTIVE.

IN THE CASE OF NATURAL RUBBER, THE DEPARTMENT OF DEFENSE HAS A PARTICULAR CONCERN. THE U.S. IS 100 PERCENT IMPORT DEPENDENT ON THIRD WORLD NATIONS FOR SUPPLY. OUR NATIONAL STOCKPILE IS ONLY 14 PERCENT OF THE INVENTORY OBJECTIVE. FURTHER, THE NATIONAL SECURITY COMMUNITY UTILIZES APPROXIMATELY 40 PERCENT OF THE TOTAL IMPORTED NATURAL RUBBER. WHILE IT IS POSSIBLE TO SUBSTITUTE SYNTHETIC RUBBER IN MANY COMMERCIAL APPLICATIONS AND TOLERATE PERFORMANCE DEGRADATION, THIS IS NOT ACCEPTABLE IN MOST DEFENSE APPLICATIONS. FOR EXAMPLE, OUR FIGHTER AIRCRAFT TIRES ARE MADE OF A HIGH PERCENTAGE OF NATURAL RUBBER IN ORDER TO MEET THE PERFORMANCE CHARACTERISTICS WHICH ARE REQUIRED TO ACCOMPLISH THE MISSION AND INSURE THE SAFETY OF THE PILOT.

FOR THE REASONS I HAVE JUST STATED, THE DEPARTMENT OF DEFENSE ACTIVELY PURSUED THE DEVELOPMENT OF NEW METHODS, TECHNIQUES AND MATERIALS TO REDUCE OUR RELIANCE ON IMPORTS IN A COST EFFECTIVE

MANNER WHILE RETAINING HIGH PERFORMANCE AND RELIABILITY. GUAYULE RUBBER FROM A NORTH AMERICAN SOURCE HAS THE POTENTIAL FOR REDUCING THE THREAT TO THE NATIONAL SECURITY POSED BY UNNECESSARY RELIANCE ON IMPORTS.

THEREFORE IN JUNE OF 1977 WE TASKED OUR SERVICE SECRETARIES TO EVALUATE NATURAL GUAYULE RUBBER AS A SUBSTITUTE FOR IMPORTED HEVEA RUBBER IN MILITARY APPLICATIONS. TESTS WERE SUCCESSFULLY COMPLETED ON BOTH NEW AND REBUILT MILITARY AIRCRAFT TIRES. IN EACH CASE TEST RESULTS INDICATED THAT GUAYULE RUBBER PERFORMED AS GOOD OR BETTER THAN IMPORTED HEVEA RUBBER. HOWEVER, AFTER COMPLETION OF APPROXIMATELY 20 PERCENT OF THE EVALUATION PROGRAM, THE ONLY SUPPLIER OF PROCESSED GUAYULE RUBBER, THE REPUBLIC OF MEXICO, DISCONTINUED OPERATION OF THEIR PILOT PLANT.

BECAUSE OF THE DEPARTMENT'S RESOLVE TO QUALIFY AN ALTERNATIVE TO IMPORTED HEVEA AND TO ELIMINATE, WHERE POSSIBLE, FOREIGN DEPENDENCIES, IN MAY OF 1982 WE INITIATED A PROGRAM FOR ESTABLISHMENT OF A PROTOTYPE DOMESTIC GUAYULE RUBBER INDUSTRY. THE PROGRAM INCLUDES GUAYULE CROP ESTABLISHMENT AND MAINTENANCE, PROCESSING TECHNIQUE DEVELOPMENT, AND FACILITY CONSTRUCTION AND DEMONSTRATION. A CONTRACT TO COMMENCE THIS EFFORT WAS AWARDED IN SEPTEMBER 1982 UTILIZING A $20 MILLION LOAN GUARANTEE UNDER THE AUTHORITY OF TITLE III OF THE DEFENSE PRODUCTION ACT. ON COMPLETION OF THIS CONTRACT, WE EXPECT SUCCESSFUL TESTING AND ECONOMIC EVALUATIONS WILL DEMONSTRATE TO THE COMMERCIAL SECTOR THE NEED FOR A DOMESTIC GUAYULE INDUSTRY. THIS CONCLUDES MY PREPARED STATEMENT. I WOULD BE HAPPY TO ANSWER ANY QUESTIONS THE COMMITTEES MAY WISH TO ASK.

Mr. BROWN. Mr. Donnelly, it sounds to me as though the Defense Department has gone ahead with the program which was contemplated for the other departments under the Native Latex Act of 1978. I commend you for recognizing the significance in the Department of Defense of this program.

I can only express my regret that the other departments did not move ahead aggressively, and you would not have had to enter into the kind of a contract that you indicated here.

Mr. DONNELLY. Mr. Chairman, I thank you for those remarks. We have many dedicated people in the Department. I will be delighted to pass on your words to them.

Mr. BROWN. Thank you.

Mr. Roberts, do you have any questions?

Mr. ROBERTS. I think the chairman's comments really prompt this question. Is the effort being undertaken by the Department of Defense separate and apart from the efforts being undertaken by the Joint Commission on Guayule Research and Commercialization?

Mr. DONNELLY. Is your question why is it separate?

Mr. ROBERTS. No.

Mr. BROWN. Is it separate?

Mr. DONNELLY. I don't believe so, sir. It is not separate. One of the first jobs of the group that we have formed within the Defense Department is to maintain coordination with the Commerce and Agriculture Departments. They have been doing very well.

Mr. ROBERTS. Again speaking as a layman, I am having a little difficulty bringing together the testimony as presented by Mr. Chambers and your testimony. Mr. Chambers has indicated that there is enough product coming from the plant in Mexico. You indicate the plant is closed. Mr. Chambers has indicated the extent of the funding by the Department of Commerce to the University of Arizona, Texas A&M, the Goodyear Tire and Rubber Co., Agribusiness Research Corp., and Texas A&M again since fiscal year 1977 to the tune of a little over $1 million, and you are talking about $20 million and it has gone to an Indian reservation.

I am having a little problem with that.

Mr. BROWN. Mr. Donnelly, would you explain how that $20 million was disposed of, what the program was?

Mr. DONNELLY. Yes, sir, I will be glad to do that. I might amplify for the record later.

[The material follows:]

LOAN GUARANTEE BACKGROUND

Congressman BROWN. Mr. Donnelly, would you explain how that $20 million was disposed of, what the program was?

Mr. DONNELLY. Please refer to answer given for Line 2100.

Mr. DONNELLY. We have not disposed of $20 million. We have a 5-year contract that was awarded to the Gila River Indian community. That was in September of 1982. That contract allows for a $20 million maximum loan guarantee. It calls for the community to submit a report on growing and processing of guayule based upon the experience gained through the project that will be supported by the loan guarantee.

Here with me some place I do have the actual amounts.

The $20 million available for the community—we have so far spent $232,000. That has been authorized so far.

Mr. ROBERTS. If I might, Mr. Chairman, if I could reclaim my time, I have several questions that I would like to have answered in regard to this, and I think it would facilitate your testimony.

How many acres are involved here? Do you have that figure, approximately?

Mr. DONNELLY. We will supply that for the record, sir.

[The material follows:]

GUAYULE ACREAGE

Congressman ROBERTS. How many acres are involved here? Do you have that figure, approximately?

Mr. DONNELLY. 1,330 acres.

Mr. ROBERTS. All right. How many tons of rubber to be produced?

Mr. DONNELLY. We will have to submit that.

[The material follows:]

RUBBER PRODUCTION CAPACITY

Congressman ROBERTS. All right. How many tons of rubber to be produced?

Mr. DONNELLY. The projected prototype output is 1000 long tons of rubber per year.

Mr. ROBERTS. If I could go further with these questions for the record, then you could submit them to the subcommittee.

What is the amount of cost to the Department in this effort? It is a loan guarantee. What are we talking about here in terms of the cost?

Mr. DONNELLY. It may not cost anything before it is all over with, sir, if we do the job right. However, let me get those answers for you.

[The material follows:]

COST TO THE DEPARTMENT OF DEFENSE

Congressman ROBERTS. What is the amount of cost to the Department in this effort? It is a loan guarantee. What are we talking about here in terms of the cost?

Mr. DONNELLY. The contract awarded to the Gila River Indian Community has a firm fixed price of $400,000. The Department will incur no costs for the loan guarantee unless the Community fails to repay the loan. (In that event, the Department would be responsible for its repayment.)

Mr. ROBERTS. All right. How long is the contract to run?

Mr. DONNELLY. Five years.

Mr. ROBERTS. The obvious bottom-line question: What is to be gained from the contract?

Mr. DONNELLY. The obvious answer we would like to have is that guayule will be qualified for use in aircraft tires and that we will be able to have a process that can be turned over to the private sector.

Mr. ROBERTS. Do you see any——

Mr. DONNELLY. We would like to get out of the facilities business just as soon as we can. Defense believes we do not make a very good landlord. To the extent we can let the private sector do its thing, that is the way we want to go.

Mr. ROBERTS. Do you see any dichotomy or difference of opinion between your testimony and that of the Department of Commerce?

Mr. ECK. No, sir. We have undertaken the DOD guayule project under the Defense Production Act to stimulate a domestic industry for guayule. I will not try to comment on why the Native Latex Act should or should not be extended. As I said, we did our project under a different authority, one that is available to us.

I do believe the Department of Agriculture and the Department of Commerce—research has been very beneficial to us, and I am sure it will continue to be beneficial.

Mr. ROBERTS. How do I get wheat promotion over there in the Department of Defense?

How often does this Joint Commission meet in regard to the interagency thing?

Mr. ECK. Sir, we are not a member of the Commission. We do sit in periodically as an advisor. The Commission is chartered by Agriculture and Commerce.

Mr. ROBERTS. Could I ask if there is anybody in the audience who could tell me how often this Commission meets?

Mr. ECK. I believe Mr. Wheaton could tell you. He is the Secretary.

Dr. WHEATON. On the average, it would meet about three times per year, or on an as-needed basis.

Mr. ROBERTS. In your opinion, have the attendance and the efforts made by the participants of this Commission been satisfactory?

Dr. WHEATON. In my opinion, yes, sir. In addition to the Commission members of the four agencies and departments that are members, we have always had representatives there or their alternates, as well as staff group members that have attended the Commission. In addition, the Commission, on its own, invited—and they have attended—the Departments of Defense, State, and the Federal Emergency Management Agency. We have worked very closely with all three of those departments or agencies in the plan that the Commission has put together, all of our activities, including the Department of Defense.

Mr. ROBERTS. Mr. Chairman, I want to make it clear that by my line of questioning in no way am I trying to be accusatory in regard to these witnesses. I am just having a little problem here in reading the testimony and getting my thoughts together. Maybe I should meet with the Commission as an observer and become better educated.

I do want to thank the witnesses for some excellent testimony. I thank you, Mr. Donnelly, for your statement. I am in full accord and share my chairman's concern in regard to the need for the extension of the act that you recently mentioned.

I have no further questions.

Mr. BROWN. Thank you very much, Mr. Donnelly. We will not belabor this further.

I am very grateful for your appearance here. If you will supply the additional information on the details of that loan guarantee, we would appreciate it.

Mr. DONNELLY. We will be pleased to do that, sir.

[The material to be supplied follows:]

LOAN GUARANTEE DETAILS

Congressman BROWN. I am very grateful for your appearance here. If you will supply the additional information on the details of that loan guarantee, we would appreciate it.

Mr. DONNELLY. Under the authority of the Defense Production Act the Department has guaranteed a loan to the Gila River Indian Community, in an amount not to exceed $20 million, to assist the Community in its efforts to establish a domestic guayule rubber industry. Under the terms of this loan guarantee, the Community may request monthly drawdowns, from the Federal Financing Bank (FFB) of the Treasury Department, on the basis of the costs it incurs in performance under its contract. During the five-year term of the contract, the Community will be required to make quarterly payments to the FFB to cover all accrued interest in the amounts borrowed. During the subsequent five years, the Community will be required to pay both principal and interest on a quarterly basis until the loan is repayed in full in 1992.

Mr. BROWN. Next I would like to call Mr. Paul K. Krueger, Assistant Associate Director for Resources Preparedness, FEMA.

STATEMENT OF PAUL K. KRUEGER, ASSISTANT ASSOCIATE DIRECTOR FOR RESOURCES PREPAREDNESS, FEDERAL EMERGENCY MANAGEMENT AGENCY

Mr. KRUEGER. Thank you, Mr. Chairman.

Mr. BROWN. Mr. Krueger, your statement will be included in the record, of course, and you may handle it in any way that you wish. I gather that your responsibilities include the national defense stockpile; is that correct?

Mr. KRUEGER. That is correct, Mr. Chairman.

Mr. BROWN. You may proceed with your statement.

Mr. KRUEGER. I think in the interest of brevity and the committees' time, I will have the statement inserted in the record and just briefly summarize some of the key points.

The Federal Emergency Management Agency coordinates many of the national security activities within Government, particularly those that involve use of the civil sector's assets.

One of the principal roles that I play in my position is concerned with the national defense stockpile, particularly the establishment of stockpile goals, the selection of which materials ought to be in the stockpile, and the alternatives to the stockpile.

The stockpile goal for natural rubber is about 850,000 long tons. In a very real way that represents our national security vulnerability. We currently have 120,000 long tons on hand. The deficit is a little over 700,000 tons.

What this means is that if we are to protect the national security, we would have to spend somewhere around $1 billion to fill up the stockpile to meet our national security needs. Therefore, it makes sense to us that if there are other ways to complete and provide for these national security objectives in a timely and cost effective fashion, and that we ought to look at that.

Accordingly, we have been very interested in guayule. We believe that if there is a successful commercialization of this product, we can reduce our national security vulnerability significantly and have done an awful lot to encourage the commercialization and development of a guayule industry.

In doing that, we work very closely with the Department of Agriculture, the Department of Commerce, and the Department of Defense. We have participated in the deliberations of the Joint Com-

mission and have been very happy to be included in those deliberations. We have also participated with the Department of Defense in their qualification program and worked closely with them on this latest effort regarding the loan guarantee.

In addition to that, we have authorized on a test basis, a pilot plant basis, the purchase of a relatively small amount of guayule for the stockpile.

I should mention, however, that even though this is a relatively small amount, there just is not any production available to do that purchase.

We have been informed, however, that the commercialization efforts described under the Native Latex Act of 1978 can be continued under existing authority. I should say that we believe firmly that research and development must be continued, perhaps increased, to develop a competitive guayule industry. Clearly, this is a long-term endeavor with extraordinary potential benefits both for the economy and for the national security preparedness.

I would like to conclude my remarks there. I would be happy to answer any questions the committee may have.

[The prepared statement of Mr. Krueger follows:]

Statement by Paul K. Krueger, Assistant Associate Director for Resources Preparedness, Federal Emergency Management Agency

Mr. Chairman and Members of the Subcommittees:

Thank you for this opportunity to testify for the Federal Emergency Management Agency (FEMA) on the domestic production of guayule.

FEMA is a relatively new organization created in 1979 to bring together key emergency management functions of five different agencies in one location. In addition to its role in national security preparedness, FEMA has responsibilities for disaster planning and relief for victims of floods, earthquakes, and volcanic activity. In the area of national security preparedness, FEMA is concerned with mobilization planning. As the Assistant Associate Director for Resources Preparedness, I am tasked with policy formulation, planning, and coordination of national security preparedness programs for national resources, including such areas as energy, transportation, labor, industrial capacity, and health services. Within this framework, I am concerned with the availability of the resources that industry uses and in the ways Government can ensure that these resources can be brought to bear during peacetime or wartime to meet national security needs. FEMA has a special responsibility in natural resources planning - the National Defense Stockpile of strategic and critical materials.

The stockpile was first established in 1939 and is comprised presently of 91 industrial materials stored at 118 locations in the United States. The stockpile is currently valued at over $11.5 billion.

One of these stockpiled items is natural rubber. Gentlemen, the U.S. is totally dependent on foreign sources of supply for natural rubber. Because of this total dependency, we must face the fact that for one reason or another, natural rubber may not be available in needed quantities during wartime.

A measure of the size of our Nation's vulnerability to shortages of strategic and critical materials is the stockpile goal. This is based on projected defense, industrial and civilian needs during three years of a national emergency. The stockpile goal for natural rubber is 850,000 long tons. Existing inventories total approximately 119,000 long tons, indicating a shortfall of about 731,000 long tons, which we can value at over $1 billion.

There are three possible ways to relieve a shortfall in the stockpile for any strategic and critical material: (1) establish a purchase program (2) develop substitutes or (3) initiate domestic production.

Regarding the first method, on March 13, 1981, the President initiated the first major purchase program for the stockpile in over twenty years. The March 13, 1981, announcement included a news release listing those materials to be considered for acquisitions for the National Defense Stockpile. Among them was natural rubber, including guayule. FEMA is actively working with the staff of the Joint Commission on Guayule Research and Commercialization and with the Department of Defense (DOD) to obtain limited quantities of processed guayule rubber for storage testing. We expect that within five years processed guayule rubber from the DOD prototype plant will be available for storage and product testing.

The second method, substitution, is often very effective. But not always. Rubber is a partial exception. Although acceptable in many applications, synthetic substitutes do not give the same performance as natural rubber in a number of defense-related uses under current technology. Even with ample supplies of synthetic rubber during a national security emergency, substantial quantities of natural rubber still will be needed to help support the industrial base for such items as aircraft and large off-the-road tires.

The third alternative may hold the greatest promise: domestic production of guayule. For example, if only one-third of the expected demand for imported natural rubber in 1990 could be satisfied by domestic guayule production, the stockpiling of natural rubber most probably could be eliminated. This is so because of the requirements of the Stock Piling Act to establish a stockpile "sufficient to sustain the United States for a period of not less than three years in the event of a national emergency". Thus, a production base equal to, say 1000 pounds of annual capacity will produce 3000 pounds we do not have to buy for the stockpile. It is because of this relationship, that we can reduce our stockpile goal by three tons for every ton of new domestic production.

FEMA supports the ongoing private and public efforts to lessen our import dependency for natural rubber through the development of a viable domestic guayule industry. We have been interested in guayule development since 1976 and have seen demonstrable progress in this area since the passage of the Native Latex Commercialization and Economic Development Act of 1978.

We have been informed, however, that the commercialization efforts described under the Native Latex Act of 1978 can be continued under existing authorities.

We believe firmly that research and development must be continued, and perhaps increased, to develop a competitive guayule industry. Clearly, this is a long term endeavor with extraordinary potential benefits both for the economy and for national security preparedness.

I will be happy to answer any questions you or the Members of the Subcommittees may have.

Mr. BROWN. Thank you very much, Mr. Krueger.

You say that if one-third of the expected demand for imported natural rubber in 1990 could be satisfied by domestic guayule production, you could eliminate stockpiling of natural rubber. Can you tell me approximately how much that demand for imported natural rubber in 1990 would be, because that one-third would then establish some reasonable scope of the market or the production?

Mr. KRUEGER. We believe it would be close to a million tons a year.

Mr. BROWN. A million tons a year.

Mr. KRUEGER. At current levels, it is about 700,000 tons. Discounting the last 2 years, which have been very poor years, as you know, for the domestic automobile industry; however, we think that a normal year would be about a million tons.

Mr. BROWN. I do not suppose that your responsibility includes the policy questions of how you commercialize a new industry like guayule development, does it, Mr. Krueger?

Mr. KRUEGER. As remarked earlier, I think it is really very much a chicken-and-egg sort of situation here. I think you have the agricultural sector, which is reluctant to go forward very quickly in the absence of any sort of market for their production.

Mr. BROWN. In the absence even of a well developed processing technology at this point.

Mr. KRUEGER. On the other hand, you have the industrial sector, which is reluctant to go forward, do the necessary research and development to develop a processing method, in the absence of any agricultural production.

I think that where there are national security interests such as this, it does make sense to try to break through this problem. We fully support the Department of Defense's efforts in trying to commercialize this. We fully support the Department of Agriculture's efforts in doing the longer term research with regard to improved gene pools, improved methods of agriculture, the experiments with direct seeding, and so forth. We think that all of these are necessary to bring together this marriage of the agricultural sector and the industrial sector.

Mr. BROWN. Mr. Krueger, has FEMA contemplated or discussed or proposed a contract offering to acquire guayule at a certain volume level in order to encourage the development of a production base?

Mr. KRUEGER. Not exactly that, sir, but we have proposed in the past a long-term program which would result in taking guayule through a development stage, which would produce some 25,000 tons of guayule a year, have a considerable amount of acreage—I think it is 75,000 acres planted. We believe that is a large enough scale to demonstrate to both the agricultural interests and the industrial interests the feasibility and viability of such a project.

We believe the cost over an 8-year period of time would be on the order of $200 million.

Mr. BROWN. That would acquire how much?

Mr. KRUEGER. I think it is something like 75,000 tons. I think the important thing there is to demonstrate on a large enough scale the technical and commercial feasibility of such a project.

Mr. BROWN. At present the Natural Latex Act does not include specific reference to a role for FEMA, if I recall it correctly.

Mr. KRUEGER. I think FEMA is mentioned in it, but it is not a member of the Commission.

Mr. BROWN. Can you envision that if the Congress decided to override the administration's recommendations not to renew the act that there could be some modification to make reference to the kind of a program that you have indicated here? I would not want to mandate it but to indicate that it might be a reasonable part of a total program to expedite the development of guayule.

Mr. KRUEGER. If, as you suggest, the act were renewed, I think FEMA would be pleased to be part of the Commission and would be very happy to take an active role to help look at the longer term projects that would guarantee commercialization.

Mr. BROWN. Mr. Roberts.

Mr. ROBERTS. I have no questions, Mr. Chairman.

Mr. BROWN. We appreciate that testimony very much, Mr. Krueger. We may want to get back to you in terms of drafting some suitable language that would comport with the needs of your agency in the event we should decide to go ahead with the extension of this act.

Mr. KRUEGER. Thank you, sir.

Mr. BROWN. Thank you.

Our next witness and our last this morning is Dr. Eloise E. Clark, Assistant Director for Biological, Behavioral, and Social Sciences of the National Science Foundation.

I do not know for sure but it may well be that the National Science Foundation helped keep this poor, struggling program alive during the dark days.

Dr. Clark, we are not anxious to keep you here unduly, but we do appreciate your being here. You may proceed with your statement in any expeditious way.

STATEMENT OF DR. ELOISE E. CLARK, ASSISTANT DIRECTOR FOR BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY DR. H. T. HUANG

Dr. CLARK. Thank you, Mr. Chairman.

I am very pleased to be here. With your permission, I will submit the full statement for the record and try to highlight briefly some of the key points.

I am accompanied this morning by Dr. H. T. Huang of our staff. He has been closely involved with the Foundation's program on guayule research for quite some years.

Mr. BROWN. Dr. Huang is welcomed. His biographical sketch will be included in the record at this point.

[Biographical sketch of Dr. Huang follows:]

Dr. H.T. Huang

Program Director, Alternative Biological Resources

Since Dr. H.T. Huang joined the National Science Foundation in 1975, he has administered a program in basic and applied research aimed at the production and utilization of renewable resources. He started as a program manager in the Research Applications Directorate, and now serves as the Program Director for Alternative Biological Resources in the Division of Physiology, Cellular and Molecular Biology, Directorate for Biological, Behavioral and Social Sciences.

The Alternative Biological Resources program supports research on the use of biological systems and biomass conversion as alternative sources of chemicals and industrial materials. Current emphasis is on microbial conversion of lignocellulose, biological nitrogen fixation and useful chemicals and materials from arid land plants.

Dr. Huang received a Bachelor of Arts degree from the University of Hong Kong in 1941 and a Doctor of Philosophy degree from Oxford University, England in 1947. He has spent 25 years as a research scientist in the chemical and pharmaceutical industry, first as a research biochemist at Rohm and Haes Co., and Pfizer Inc. and later as the Research Director for Biological Sciences at International Minerals and Chemical Corporation. He was involved in research in enzyme technology, the production of antibiotics, nucleotids, and microbial insectides by fermentation and the development of new agricultural chemicals.

Dr. Huang has worked on a number of interagency committees. He has represented NSF on the Joint Subcommittee on Human Nutrition Research, the Inventory of Research Extension and Higher Education Related to Food and Agriculture and the Joint Commission on Guayule Research and Commercialization.

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Dr. CLARK. I became the Foundation's designated representative to the Joint Commission approximately a year and a half ago as a consequence of a reorganization at the Foundation which assigned responsibilities for the program to my directorate. Dr. Huang has served for some time as the alternate representative and also a member of the staff group of the Joint Commission

It might be useful to indicate briefly something about the character of the Foundation's research support; namely, that for the most part we respond to research ideas that are initiated by the scientific investigators in the research community. We will periodically designate areas as we have done currently in plant biology, for special emphasis, but by and large we aim to select the most important and promising research that we see on the broader scientific horizon, applying standards of excellence and full peer review based on the scientific merit of the project.

I might indicate that operating under this system the Foundation began its support in 1976 for the guayule program under the research applied to national needs activity of the Foundation. That was part of a larger effort to explore alternative biological resources to replace or supplement resources that were in short supply or perhaps becoming increasingly expensive.

I think it is fair to say that the Foundation was quite foresighted in responding to the interest of a few enlightened scientists and certainly some Members of the Congress in initiating this program before the formal passage of the Native Latex Act.

Between 1976 and 1982, we have spent approximately $2.4 million. That is outlined in detail and the projects are described briefly in the tables accompanying the testimony.

Mr. BROWN. You did say $2.4 million?

Dr. CLARK. Yes. $2.4 million.

Part of this was undertaken in response to a panel study developed by the National Academy of Sciences which recommended a number of important directions; namely, to undertake support that would lead to commercialization of the plant, to undertake collaborative support research between the United States and Mexico, to initiative a breeding program, to develop experimental plantings, and to establish a central research records system.

We responded to a number of these initiatives, and I might say that some of those that we started have now been transferred to the Department of Agriculture and are being continued.

I will not go into great detail, but we have chosen to identify two or three important results arising from the research, in part to indicate the need for continued effort before we can fully understand the biology of the system and be able to exploit it to its fullest commercial potential, but also to indicate the promising opportunities that have arisen from some of the research support, in particular the potential development of use of a natural chemical bioregulator which can stimulate the yield of the rubber in the guayule plant from two- to threefold. That, unfortunately, has not been carried over to practical use in the field, but tests are underway that may lead to its potential development at sometime in the not-too-distant future.

Attempts are underway to identify the site of specific reaction of the bioregulator. That has been located as the very last step in the

biosynthesis of the natural rubber, and I think that further studies might lead to insights about how to use this bioregulator in practical field situations.

Mr. BROWN. You realize, Dr. Clark, that if you could succeed in developing that bioregulator and it doubles the production that you could pay the whole budget the NSF out of the gains?

Dr. CLARK. We would love to be able to contribute in such a way.

Mr. BROWN. All right

Dr. CLARK. Another promising area is the use of tissue culture, and we have continuing efforts to try to increase the efficiency of this procedure so that selection of plants with highest rubber yield or other desirable properties can be expedited for mass cultivation.

A third project concerns somewhat of a sideline but is certainly very important to the potential commercialization or exploitation of the plant, in that studies are underway to look at potentially or possibly allergenic substances. Two such compounds have been identified and have been shown to cause allergies in guinea pigs. Tests are underway to see if the same problems would confront human beings, in which case we would have to allow for this possibility in developing any commercialization in the future.

I might close by reminding you that we do respond to unsolicited proposals from the scientific community. It is our full intention, so long as the quality of research in this area remains high, to continue to support active projects in the future. From that point of view, our supportive role underlying the potential commercialization of the plant really does not depend on the reauthorization of the act.

Mr. BROWN. I guess we can say that we are fortunate that your continued funding of research in this area does not depend on reauthorizing the act. On the other hand, it probably will not influence us too much in our decision as to whether to reauthorize the act.

Dr. CLARK. I understand.

[The prepared statement of Dr. Clark follows:]

Statement of Dr. Eloise E. Clark, Assistant Director for Biological, Behavioral, and Social Sciences

Mr. Chairmen and Members of the Subcommittees:

Thank you for the opportunity to report to you on the research activities of the National Science Foundation related to the provisions of the Native Latex Commercialization and Economic Development Act of 1978, PL-95-592. I am accompanied this morning by Dr. H.T. Huang of our staff who has been closely involved in the Foundation's support of research on guayule and other arid land plants.

At the outset, I should note two important aspects of the Foundation's support of research. First, for the most part, the Foundation responds to research proposals initiated by the scientific community. Although the Foundation does identify broad areas of research -- such as plant biology -- which hold particular promise at this time for significant scientific contributions, it does not usually attempt to indicate in advance specific topics on which research proposals are solicited. Second, selection of research projects for support is based primarily on peer evaluations of the scientific and technical merits of the proposals submitted. Thus, we rely mainly on members of the scientific research communities to define and propose research on topics they see as timely, important and most likely to advance the state of knowledge. Such proposals must meet the high test standards of scientific merit as judged by experts in the specific area of study.

At present, very nearly all of the research on guayule at NSF is supported by the Biological, Behavioral, and Social Science Directorate (BBS). But it may be of interest to note for the record that the Foundation's support of such research began as early as 1976 under the Research Applied to National Needs

ACTIVITY OF NSF. THE RESEARCH WAS PART OF A LARGER EFFORT TO EXPLORE AND FIND ALTERNATIVE BIOLOGICAL RESOURCES TO REPLACE OR SUPPLEMENT RESOURCES THAT WERE IN SHORT SUPPLY OR WHICH WERE BECOMING INCREASINGLY EXPENSIVE. IN MARCH 1981, RESEARCH SUPPORT FOR GUAYULE AS PART OF THE ALTERNATIVE BIOLOGICAL RESOURCES PROGRAM WAS TRANSFERRED TO BBS WHICH HAS CONTINUED TO SUPPORT SUCH WORK.

I BELIEVE IT IS NOT CLAIMING TOO MUCH TO SAY THAT THE FOUNDATION DEMONSTRATED CONSIDERABLE FORESIGHT IN IDENTIFYING THIS BROAD AREA OF BASIC AND APPLIED RESEARCH AT A TIME WHEN THE RESEARCH NEEDS WERE NOT WIDELY RECOGNIZED.

AS SHOWN IN TABLE I, BETWEEN FISCAL YEARS 1976 AND 1982, THE FOUNDATION OBLIGATED A TOTAL OF $2.4 MILLION FOR RESEARCH ON GUAYULE (TABLE 1). THE SPECIFIC PROJECTS SUPPORTED BY THE FOUNDATION ARE LISTED IN TABLE II.

A GOOD DEAL OF THE RESEARCH ON GUAYULE WAS STIMULATED BY THE REPORT OF AN AD HOC PANEL ASSEMBLED BY THE NATIONAL ACADEMY OF SCIENCES. ITS TITLE IS "GUAYULE: AN ALTERNATIVE SOURCE OF NATURAL RUBBER", AND IT WAS PUBLISHED IN MARCH 1977. THAT REPORT RECOMMENDED FEDERAL SUPPORT OF RESEARCH AND DEVELOPMENT LEADING TO COMMERCIALIZATION OF THE GUAYULE PLANT; COLLABORATIVE RESEARCH ON GUAYULE BETWEEN THE U.S. AND MEXICO; INITIATION OF A GUAYULE BREEDING PROGRAM; EXPERIMENTAL PLANTING OF GUAYULE IN GEOGRAPHIC AREAS OF THE U.S. AND MEXICO THAT APPEARED TO BE SUITED TO THE PLANT; AND THAT THE FEDERAL GOVERNMENT MAKE RESEARCH RECORDS ACCESSIBLE AT A CENTRAL LOCATION IN THE SOUTHWEST.

IN 1979, THE JOINT COMMISSION ON GUAYULE RESEARCH AND COMMERCIALIZATION WAS ESTABLISHED UNDER THE NATIVE LATEX COMMERCIALIZATION AND ECONOMIC DEVELOPMENT

ACT. THE DEPARTMENTS OF AGRICULTURE AND COMMERCE WERE NAMED AS THE LEAD AGENCIES. THE DEPARTMENT OF THE INTERIOR AND NSF ARE ALSO REPRESENTED ON THE JOINT COMMISSION.

AS YOU WILL NOTE FROM THE PROJECTS IDENTIFIED IN TABLE II, MUCH OF THE INVESTIGATOR-INITIATED RESEARCH SUPPORTED BY THE FOUNDATION WAS INDEED RESPONSIVE TO THE RECOMMENDATIONS MADE IN THE 1977 REPORT OF THE NATIONAL ACADEMY OF SCIENCES. YOU MAY ALSO NOTE THAT MANY OF THE PROJECTS STARTED UNDER NSF FUNDING, FOR EXAMPLE, THE PLANT BREEDING PROGRAM, WATER USE AND AGRONOMIC PRACTICES, AND HERBICIDES FOR WEED CONTROL ON GUAYULE PLANTATIONS, ARE BEING CONTINUED AS PART OF THE USDA'S PROGRAM.

I SHOULD LIKE TO SUMMARIZE A FEW SIGNIFICANT SCIENTIFIC RESULTS OF THE NSF-SUPPORTED RESEARCH AND POINT OUT SOME OF THEIR IMPLICATIONS FOR THE FUTURE OF GUAYULE DEVELOPMENT.

NATURAL RUBBER IS A MEMBER OF A LARGE FAMILY OF NATURAL PRODUCTS DERIVED FROM A FIVE CARBON MONOMER CALLED ISOPRENE. THE ISOPRENOID FAMILY INCLUDES SUCH WELL KNOWN SUBSTANCES AS TERPENES, STEROIDS, AND CAROTENOIDS, THE PIGMENTS RESPONSIBLE FOR THE FAMILIAR YELLOW, ORANGE AND RED COLORS FOUND IN FRUITS AND VEGETABLES. IT HAS BEEN KNOWN FOR MANY YEARS THAT SOME CHEMICAL BIOREGULATORS, FOR EXAMPLE, DICHLOROPHENOXYTRIETHYLAMINE (DCPTA) CAN INDUCE THE SYNTHESIS OF A SPECIAL TYPE OF PIGMENTS KNOWN AS *CIS*-CAROTENOIDS IN LEMONS AND GRAPEFRUITS. THESE CAROTENOIDS HAVE THE SAME KIND OF THREE DIMENSIONAL CONFIGURATION AS NATURAL RUBBER, WHICH IS A *CIS*-POLYISOPRENE. SINCE *CIS*-CAROTENOIDS AND *CIS*-POLYISOPRENE ARE BOTH DERIVATIVES OF ISOPRENE, AND DCPTA ENHANCES THE SYNTHESIS OF *CIS*-CAROTENOIDS ONE MIGHT EASILY ASK THE

QUESTION: WOULD DCPTA ALSO ENHANCE THE SYNTHESIS OF NATURAL RUBBER? THIS IDEA WAS TESTED EXPERIMENTALLY AND IN ONE OF THE MOST EXCITING MOMENTS IN GUAYULE RESEARCH IN RECENT YEARS IT WAS FOUND THAT TREATMENT OF GUAYULE WITH THE BIOREGULATOR DCPTA CAN, UNDER APPROPRIATE CONDITIONS, INCREASE THE YIELD OF RUBBER TWO TO THREE FOLD. THIS WAS A MOST GRATIFYING DISCOVERY. UNFORTUNATELY, SO FAR WE HAVE NOT BEEN ABLE TO TRANSFER THIS PHENOMENON INTO FIELD PRACTICE. TREATMENT OF GUAYULE PLANTS WITH DCPTA IN LARGE FIELD PLOTS HAVE ALL GIVEN EQUIVOCAL AND ERRATIC RESULTS. THE REASON FOR THIS DISCREPANCY MAY NOW BE FORTHCOMING FROM A PROJECT AT TEXAS A&M UNIVERSITY AIMED AT ELUCIDATING THE MECHANISM BY WHICH THE BIOREGULATOR IS ABLE TO INFLUENCE THE SYNTHESIS OF RUBBER IN GUAYULE. BY MEASURING THE LEVELS OF ENZYMES INVOLVED IN THE SYNTHESIS OF RUBBER FROM ISOPRENE IN GUAYULE PLANTS BEFORE AND AFTER TREATMENT WITH DCPTA IT HAS BEEN POSSIBLE TO IDENTIFY THE SPECIFIC REACTION ON THE BIOSYNTHETIC PATHWAY OF RUBBER SYNTHESIS THAT WAS STIMULATED BY THE BIOREGULATOR. IT TURNED OUT TO BE THE VERY LAST STEP IN THE SYNTHESIS OF RUBBER, THAT IS, THE POLYMERIZATION OF THE ISOPRENOID PRECURSOR INTO NATURAL RUBBER. FURTHER STUDIES ON THE EFFECT OF DCPTA ON THE DEVELOPMENTAL BIOCHEMISTRY OF GUAYULE MAY WELL PROVIDE USEFUL LEADS TO ENABLE THE GROWER TO USE THE BIOREGULATOR SUCCESSFULLY IN THE FIELD. IF SO, THIS COULD ALMOST DOUBLE THE PRODUCTIVITY OF EXISTING GUAYULE CULTIVARS OVERNIGHT AND WOULD GREATLY ENHANACE THE ECONOMIC FEASIBILITY OF GUAYULE AS AN AGRICULTURAL CROP.

ANOTHER INNOVATIVE APPROACH SUPPORTED BY NSF IS TISSUE CULTURE. RESEARCH CONDUCTED AT THE UNIVERSITY OF CALIFORNIA, RIVERSIDE AND THE UNIVERSITY OF CALIFORNIA, IRVINE INDICATES THAT IT IS POSSIBLE TO REGENERATE WHOLE PLANTS FROM EXPLANTS OF GUAYULE IN TISSUE CULTURE. EFFORTS ARE CONTINUING TO INCREASE THE EFFICIENCY OF THIS PROCEDURE SO THAT IT CAN BE USED ROUTINELY FOR

THE SELECTION OF PLANTS WITH HIGH RUBBER YIELD OR OTHER DESIRABLE PROPERTIES, AND FOR THE MASS PROPAGATION OF SUPERIOR CULTIVARS THAT CANNOT BE PROPAGATED BY CONVENTIONAL MEANS.

A THIRD PROJECT THAT I WOULD LIKE TO MENTION IS THE CHEMICAL IDENTIFICATION OF ALLERGENIC SUBSTANCES IN THE RESIN FRACTION OF GUAYULE. TWO COMPOUNDS WHICH ELICIT ALLERGENIC REACTIONS IN GUINEA PIGS HAVE BEEN ISOLATED AND THEIR CHEMICAL STRUCTURE DETERMINED. BOTH ARE SESQUITERPENE LACTONES. CURRENTLY, THEIR ALLERGENICITY IS BEING TESTED ON HUMAN VOLUNTEERS BY THE DERMATOLOGY DEPARTMENT, UNIVERSITY OF CALIFORNIA SCHOOL OF MEDICINE, SAN FRANCISCO. IF THEY SHOULD PROVE TO BE SERIOUS ALLERGENS FOR PEOPLE, METHODS WILL HAVE TO BE DEVELOPED TO MINIMIZE EXPOSURE OF WORKERS TO THESE COMPOUNDS DURING THE RUBBER RECOVERY PROCESS.

FINALLY, AS I MENTIONED EARLIER, NSF SUPPORT FOR RESEARCH ON GUAYULE IS THE RESULT OF UNSOLICITED PROPOSALS FROM THE SCIENTIFIC CCOMMUNITY. WE EXPECT TO CONTINUE TO SUPPORT HIGH QUALITY RESEARCH IN THE AREA AND THEREFORE BELIEVE IT IS NOT NECESSARY TO REAUTHTORIZE THE ACT.

DR. HUANG AND I WILL BE PLEASED TO RESPOND TO ANY QUESTIONS THAT YOU MAY WISH TO ASK.

TABLE I

NSF Obligations for Research on Guayule,
Fiscal Years 1976-82

FISCAL YEAR	$1,000
1976	37.5
1977	97.6
1978	612.5
1979	645.2
1980	525.5
1981	329.8
1982	132.5
Total	2,380.6
1983	est. 250.0

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

INVESTIGATOR & INSTITUTION	$1,000	GRANT PERIOD	PURPOSE
P. Phillips University of Utah	20.3 b/	07/80-08/82	Characterization, morphology and kinetics of guayule rubber crystallization, to facilitate our understanding of the relationship between processing variables and the microstructure and molecular length of guayule rubber.
J. White University of Tennessee	31.5 b/	06/80-06/82	Compare rheological properties of guayule rubber with hevea rubber and synthetic cispolyisoprenes in order to assess the utility of guayule rubber as a commercial substitute for other rubbers.
A. Verbiscar Anver Bioscience	102.0 c/ 104.5	01/80-01/81 01/81-01/82	Guayule byproducts and rubber analysis. The composition of seed and leaves of guayule has been determined. A new IR method to assay rubber content in guayule stem samples is being developed.
D. Rubis University of Arizona	26.4 100.3	09/76-02/78 09/79-09/80	Seed Collection and Study Genetics, Cytogentics and Breeding Seed collection in Northern Mexico was carried out in 1976-78. Evaluation of germplasm and breeding studies are continuing under USDA-CSRS grant.

c/ Funded by NSF's Small Business Innovation Program.

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION [a/]

INVESTIGATOR & INSTITUTION	$1,000	GRANT PERIOD	PURPOSE
K. Foster University of Arizona	258.7	09/78-11/79	Technology Assessment of Guayule Commercialization focused on social, economic, institutional and environment consequences. Final report issued in May 1980. No adverse effects were identified.
	92.9 [b/]	08/80-09/81	Technology Assessment for Mexico is being carried out by U.S. and Mexican scientists.
	9.2	10/81-07/82	
D. Bragg Texas A&M University	130.7	01/79-03/80	Analysis of Market and Production Cost of Guayule Rubber based on currently available technology. Final reports issued in September 1980. Results indicate that there is a market for guayule rubber, although the cost of the rubber will be initially noncompetitive.
D. McIntyre University of Akron	11.1 [b/]	05/76-04/78	Physical Properties and Efficacy of Guayule Rubber.
	76.3	05/78-04/78	
	36.9	08/80-08/82	Efficacy of Guayule and Byproducts. Significant progress has been made under NSF support on elucidation of the nature of branching and gel distribution in guayule rubber products. Current study will focus on how native cellular guayule rubber may differ from latex duct hevea rubber.

a/ Total expenditure to date (12/81) - $2,500,000.
b/ Joint project with Centro de Investigcion en Quimica Applicada (CIQA), Saltillo, Mexico

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

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P. Phillips University of Utah	20.3 b/	07/80-08/82	Characterization, morphology and kinetics of guayule rubber crystallization, to facilitate our understanding of the relationship between processing variables and the microstructur and molecular length of guayule rubber.
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c/ Funded by NSF's Small Business Innovation Program.

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

INVESTIGATOR & INSTITUTION	$1,000	GRANT PERIOD	PURPOSE
G. Hanson Los Angeles Arboretum	97.6 90.9 144.1 117.2	04/77-03/78 04/78-03/79 04/79-03/80 04/80-11/80	Seed Collection, Breeding, Selection & Horticultural Studies Seed collection in Northern Mexico was completed in 1978. Evaluation of germ plasm and breeding studies continue under USDA/CSRS grant.
H. Yokoyama Los Angeles Arboretum G. Hanson USDA/S&E	55.9 66.2 44.1	05/78-04/79 05/79-05/80 05/80-12/80	Bioregulator treatment has given rise to enhancement of rubber yield in guayule under nursery and small plot conditions. Experiments in the field are now being conducted as part of USDA/ARS program.
T. Murashige University of California Riverside	72.5 80.6	12/78-11/79 01/80-01/81	Regeneration of guayule plants from cell and tissue culture has been achieved. Efforts now concentrate on vegeneration with increased efficiency and level of survival in the field.

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

INVESTIGATOR & INSTITUTION	$1,000	GRANT PERIOD	PURPOSE
E. Rodriguez University of California Irvine	53.3 89.3	02/79-01/80 07/81-06/83	Ascertain Allergenicity of Guayule Dermatotoxicological Studies of Guayule and Hybirds Two allergenic substances were isolated from guayule resins, guayulin A and guayulin B, using the guinea pig as the test animal. Experiments are now in progress to determine the effect of these compounds on humans.
H. Bloss University of Arizona	30.7 45.2	03/79-09/80 05/81-11/82	Mycorrhizal association in guayule were easily established with locally isolated organisms. Early results in a field experiment indicates the mycorrhizal treatment increases the the hardiness and growth rate of transplanted seedlings.
C. Benedict Texas A&M University	49.6 81.6	08/79-08/80 09/81-08/82	The regulation of rubber formation in guayule is being investigated at the molecular level. The overall goal is to elucidate the mechanism of induction of rubber synthesis by cold or by chemical regulators. The results will advance the ability of researchers to use bioregulator effectively in the field and to manipulate the plant gentically for the breeding of superior cullivers.
D. Fangmeier University of Arizona	82.7	09/79-09/80	The water use and production practice project is being continued under USDA/CSRS grant.

GUAYULE PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

INVESTIGATOR & INSTITUTION	$1,000	GRANT PERIOD	PURPOSE
G. Hanson Los Angeles Arboretum	97.6 90.9 144.1 117.2	04/77-03/78 04/78-03/79 04/79-03/80 04/80-11/80	Seed Collection, Breeding, Selection & Horticultural Studies Seed collection in Northern Mexico was completed in 1978. Evaluation of germ plasm and breeding studies continue under USDA/CSRS grant.
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T. Murashige University of California Riverside	72.5 80.6	12/78-11/79 01/80-01/81	Regeneration of guayule plants from cell and tissue culture has been achieved. Efforts now concentrate on vegeneration with increased efficiency and level of survival in the field.
J. Miller Sul Ross State U.	52.4	01/82-1/83	Define biological factors which affect rubber yield in wild stands of guayule in selected sampling grids in Texas and Mexico

Mr. BROWN. Mr. Penny, do you have any questions?

Mr. PENNY. No, I have no questions of this witness.

Mr. BROWN. My reaction to your presentation is wholly favorable. That should be no secret to you—that I appreciate the contribution which the Foundation makes to the support of beneficial research, and I am particularly grateful when it happens to coincide with some of my own peculiar interests, so I am very pleased with what you have done.

The table that you have shown indicating the support over the years is probably the most stable part of the overall guayule research program. However, as you also know from long exposure to me, I think there is a research problem here which you are totally and completely neglecting, and that is the social research involved and how you translate a development of this sort into social application; that is, how you proceed along a line that leads from fundamental research to the demonstration of a useful product, to the exploitation or commercialization of that product.

You and I both know that that kind of research is fraught with all sorts of political problems, but so is risk assessment on cancer, for example.

One of the things that intrigued me by the Academy's recent study on cancer risk assessment was their insistence that you could divide that into two problems: A scientific risk assessment process and a political risk management process.

Now I think you should be exploring how to do the same thing in dealing particularly with social problems like this over at NSF, particularly in view of the prevalence of this same generic problem at many levels in the Government at this time.

That is more or less dicta, but if you or Dr. Huang have any comments on it—you will tell me, I am sure, that you do not get any good research proposals of this sort.

Dr. HUANG. Indeed, we do not up to this point.

Mr. BROWN. Up to this point. I keep hoping so.

Dr. CLARK. As you say, it is an area fraught with difficulties, but the point is well taken.

Mr. BROWN. Inasmuch as we will not be able to solve that problem this morning, I do not think I need to pursue this any further. Let me ask you one thing.

You are projecting a very large figure for support in 1984, research in this area. Does this mean that you are continuing to get a stream of good research proposals in the guayule area?

Dr. CLARK. I think that is true. Dr. Huang can describe that in more detail. My guess also is that following on the results of the identification of the role of the bioregulators that that is likely to stimulate some enhanced activity.

Mr. BROWN. Do you want to comment on that, Dr. Huang?

Dr. HUANG. We are projecting a small increase.

Dr. CLARK. For 1983.

Dr. HUANG. For 1984.

Dr. CLARK. For 1984.

Yes. We consider this part of our emphasis in plant biology. As you know, there is a certain cyclical kind of phenomenon to research proposals. Some years we receive a low number, and on others there may be a large increase.

Dr. HUANG. We hope that with the current increasing interest in guayule there will be more people attracted to the field. This has been our experience in the last couple of years. We are anticipating an increase in the number of proposals.

Mr. BROWN. Dr. Huang, you have been meeting with the Commission; is that right?

Dr. HUANG. Yes.

Mr. BROWN. As an observer, a participant?

Dr. HUANG. On the staff group of the Commission as well as the alternate member for the foundation.

Mr. BROWN. I see. The members of the Commission are informed as to the potential of new research developments? For example, there is the possible impact of the bioregulators on guayule production.

Dr. HUANG. Yes. That is very much so.

Mr. BROWN. Therefore, the Commission, in making their estimates of the future of developments in this area, would be aware of the possibility of increasing production of 1,000 to 2,000 pounds per acre?

Dr. HUANG. Yes.

Dr. CLARK. If I might just add, Mr. Chairman, I believe one of the things that has happened in recent years—and I say this perhaps with not an adequate historical perspective—but I believe there has been better interagency cooperation among concerned agencies, not just in this area but across the broader spectrum of biological research. Perhaps it comes from the realization that our growth of funds is curtailed relative to past years, but that I find a very healthy development. I think there is a good spirit of exchange among the scientific agencies, and our interactions have certainly improved in recent years with the Department of Agriculture. That I would like to see continued very much.

Mr. BROWN. I assure you that we would like to see it continued. I am pleased to hear your report that you think it is improving.

I will not keep you any longer, Dr. Clark and Dr. Huang. I very much appreciate your being here this morning and filling out the record on what I consider to be a very important subject, even though others do not always agree with me. We will keep in touch with you with regard to the matter.

The subcommittees will be in recess until 2 p.m. this afternoon in room 2318.

[Whereupon, at 12:10 p.m., the subcommittees recessed, to reconvene the same day, Thursday, March 24, 1983, at 2 p.m.]

AFTERNOON SESSION

Mr. BROWN. The subcommittees will come to order.

Were you gentlemen present at the hearing this morning?

Mr. SALISBURY. Yes.

Mr. BROWN. What we are trying to do, as I am sure you are aware, is to establish an adequate record to justify a decision one way or another on the continuation of the so-called Guayule Act. Each time we do this, we have to go through the process of educating a lot of Members of Congress over again as to the background, history, and importance of this relatively minor program but one

which for a number of reasons attracts a good deal of interest in various places.

We are looking to this panel this afternoon to give us a nonbureaucratic or nongovernmental viewpoint on the work that is going on and the potential of further development in this area. We are trying to look at it from both the microcosmic and the macrocosmic standpoint, that is, as an example of development in one plant but also as a prototype of how the Government could function in bringing into commercial development what could be a fairly substantial contribution to our national security and national welfare.

With that brief introduction, Mr. Salisbury, I understand you have a plane to catch and would like to be accommodated. I would be pleased to do that. You have a statement, and you may proceed first. If you care to summarize or abbreviate, the full text of your statement will appear in the record.

STATEMENT OF CHUCK SALISBURY, REPRESENTING PACIFIC RUBBER GROWERS

Mr. SALISBURY. Thank you very much.

First of all, I want to thank the committee for inviting Mr. Hugh Anderson, who I represent, of Pacific Rubber Growers in Pasadena, Calif. I have some prepared remarks from Mr. Anderson which I would like to have submitted as a part of the record.

In addition, I have a proposal which I will just briefly outline which will also be a part of the record.

Mr. Anderson's comment to me was to thank you, Mr. Brown, for your past efforts in keeping this issue of guayule preservation and need of guayule alive. He recognizes the contribution you have made, and the efforts are well-deserved because guayule is necessary.

The need for new rubber, the diminishing supply of the world's oil, and the resulting higher prices in the world market has resulted in a search for alternate sources of power and various means to conserve petroleum. About 70 percent of the world's rubber supply comes from synthetic rubber made from oil derivatives. Specialists are searching for adequate substitutes. A total of 10.1 million metric tons of rubber, both natural and synthetic, were utilized worldwide in 1973.

Rubber produced from the guayule plant, a desert shrub indigenous to the Southwest, has been found by agricultural specialists to be the most adequate and economic alternative source of rubber. Evidence of the concern and encouragement of the U.S. Government was shown by the sponsorship of an international conference on the utilization of guayule in 1975 at the University of Arizona. Since that time, the Government funded a $20 million rubber-growing program with the Gila River Indian Community in Arizona.

In March 1978 testimony was requested from the president of Pacific Rubber Growers, Hugh Anderson, who I represent, to endorse legislation sponsored by Senator Domenici. The Guayule Demonstration and Economic Development Act of 1978 was the result. This bill was approved in May 1978, authorizing funding in the amount of $30 million total during the next 5 years with funding to be allocated by the Department of Commerce and the Department

of Agriculture. We have heard this morning, of course, what both have done in this interim period of time.

The world's natural tree rubber supply is being diminished as rubber tree plantation owners in Southeast Asia are starting to dig out their rubber trees and replace them with oil palms because of the increasing cost of the labor required for tree rubber. Reliable observers report tree rubber plantation acreage has been reduced in excess of 20 percent during recent years.

Pacific Rubber Growers is a California corporation founded in October 1965—it is my understanding, I believe, that we are the only private venture represented today as a witness during these hearings—with predecessor operations in guayule under the same ownership. It holds existing technical knowledge for the production of parthenium rubber from the guayule shrub. The firm also has, as a proprietary process, a process for extracting 99 percent of the rubber from the cells of the guayule plant.

I heard from the Department of Agriculture this morning that there is experimentation going on continually in Peoria, Ill., which happens to be my home city. Now I know that Peoria, Ill., needs all the extravagant publicity that it can get in any particular endeavor, but I also read a report that goes back to 1977, where the USDA in 1977 was also trying to get an extraction process out of that location in Peoria. It is 1983, gentlemen.

This proprietary process which Pacific Rubber Growers has, and has continually represented as being available, is a continuous process and works by a chopping and cell disintegration system. The company has utilized a special solvent which separates industrial chemicals in the rubber. The company, Pacific Rubber Growers, maintained a large planting—1,150 acres—for several years and operated an extraction mill. This was in Beaumont, Calif. Research based on this operation has continued during 35 years.

The company's staff consists of the most experienced scientists in both the growing and harvesting of the guayule plant and in the process of extraction. In addition, Pacific Rubber Growers has the only known commercial quantity of standardized guayule seeds sufficient for production of guayule seedlings for over 10,000 acres. Despite the testimony of others, there is sufficient seed currently available for planting of 10,000 acres. The company also holds detailed information for growers on the best scientific methods of planting, growing, and harvesting the guayule shrub.

Confidence in the future of guayule as a future world source of natural rubber and in the capabilities of Pacific Rubber Growers has been expressed by one of the largest tree rubber growers in Malaysia, who has awarded Pacific Rubber Growers an order for 10,000 tons of their superior parthenium rubber at market price at time of delivery. This fact was also made available during the committee hearings in 1978. The order still stands; it is from Sime Darby.

To replace the 10.1 million metric tons of rubbers produced from both tree rubber and synthetic oil derivatives would require the growth of over 10.3 million acres of guayule. An acre of guayule produces about 3,000 pounds of high-grade rubber once every 4 years. At a price of 45 cents per pound, this represents a potential

$10.2 billion market for guayule as it slowly replaces other forms of rubber.

The use of rubber throughout the world has increased at an average rate of 8 percent per year. In addition to its major use for vehicle tires, guayule rubber is particularly soft and flexible and can be used advantageously for cements and frictions, adhesives, chewing gum, clothing, milking machine inflations, as well as other products.

In addition to its rubber, Pacific Rubber Growers' proprietary extraction process produces other valuable byproducts which are commercially marketable. These include a paper pulp from the bulk of the plant after the rubber is extracted. This paper pulp has been tested as a result of earlier experimentation by Pacific Rubber Growers; the paper pulp would produce a high grade paper, and two paper companies would be vitally interested in purchasing this paper pulp from whoever produces it.

In addition, after the rubber is extracted there are industrial chemicals, resulting in an array of organic chemicals from paint extenders to pharmaceutical products from the resins which are removed to harden the rubber, and a carnuba-like wax and fertilizer from the leaves are also commercially viable.

It is accurately estimated continuously by Pacific Rubber Growers that the rubber itself, which is one of the main byproducts from guayule, would be the profit potential. By that I mean that the other items—the paper pulp, the resin, the wax—would themselves be commercially viable and would produce enough income to justify the planting. The excess and the profit would come from selling rubber, whatever the world price happened to be at that particular point in time.

Pacific Rubber Growers estimates that a minimum economic planting of guayule is 10,000 acres in one area. Due to the great profitability and the tentative commitments of large sections of land, they propose to develop a 100,000-acre plantation, especially because of the increasing need for natural rubber. In an assured market, the success of an undertaking of this size is all but guaranteed.

As mentioned earlier, the Government has granted a $20 million guarantee for the development of guayule rubber through the Defense Department. Legislation requires a natural rubber stockpile of 500,000 tons; currently the inventory is approximately 100,000 tons. Previous encouragement by Mr. Anderson has resulted recently in joint exploratory work between the Australian Government and the U.S. Government, investigating the feasibility of devoting large land areas in Australia to this crop.

The quality of rubber from guayule is equal and/or superior to any other known source. The byproducts are of substantial value, and Pacific Rubber Growers has detailed plans for the construction of the extraction and processing facilities. All these factors are making this project economically attractive.

The guayule shrub requires a minimum of 4 years of growth before harvesting, so obviously the first crop would not come until 4 years after the first planting. The plant must be plowed out and baled and the shrub hauled to the factory.

Without going any further, the entire report and proposal is before the committee. I would like to just end with a few comments and observations as a result of my feelings about the guayule project:

No. 1 in 1978 Mr. Hugh Anderson was here and gave essentially a report which encouraged at that time the need for a $15 million minimum for the realization of a 10,000-acre plantation; 4 years later we do not have a 10,000-acre plantation, and the seed which was offered at that time is still available. The seed, and the quality of the seed, is mentioned in this report; it is 893; it is available.

The financial projections which were given in 1978 have increased because time has delayed the start of the project. Whereas before we proposed to do 10,000 acres for $15 million, now we are looking at a proposal to do the same 10,000 acres for a cost of $30 million.

Had appropriations been made available to Pacific Rubber Growers at that time, today, gentlemen, we would have 10,000-plus acres of guayule growing. We would have an extraction process already completed. We would be producing rubber for sale to the Department of Defense or anyone else that would be the sole purchaser. We are 4 years later. Pacific Rubber Growers has not made sufficient progress during those 4 years and, as I found out today, neither has anyone else.

Thank you.

Mr. BROWN. Thank you very much, Mr. Salisbury.

The full content of the reports that you have presented will be made a part of the record. I would appreciate it if you would express my thanks to Mr. Anderson. I talk to him enough to know how frustrated he is about this situation——

Mr. SALISBURY. Yes, sir.

Mr. BROWN [continuing]. I share his frustration. As you know, the act originally authorized $30 million over 5 years and it has never reached that level. The total amount actually appropriated and expended under that is about a quarter of that amount. I think that has been a serious error, but there is little that any one person could do about it. Even important Members of Congress like me have our limitations.

Mr. SALISBURY. That is a temporary condition, and I am sure with another 20 years you will be able to overcome that. [Laughter.]

Mr. BROWN. In another 20 years I will be able to overcome it, right.

Mr. Skeen, do you care to address any questions to Mr. Salisbury?

Mr. SKEEN. No, Mr. Chairman. I apologize for being late. I had a deep interest in what he had to say, but I have no questions, and I am sure you are relieved.

Mr. BROWN. Mr. Salisbury, if you feel it necessary to leave at any point we understand, and we will be glad to excuse you. If you can remain, I would like to let the remainder of the panel make their statements and then we will have some additional questions.

Mr. SKEEN. Before we begin, Mr. Chairman, I appreciate the courtesy that you have extended to me in introducing a gentleman who comes from a university that we are very proud of in New

Mexico, and that is New Mexico State University. He is Dr. Merle Niehaus, who is chairman of the Guayule Administrative Management Committee. He is head of the crop and soil sciences department at New Mexico State University.

We are delighted to have you here. Thank you so much for coming.

Thank you, Mr. Chairman.

Mr. BROWN. The list I have shows Dr. Dodd first in order, and having no better guide to go by, we will let you proceed first, Dr. Dodd.

STATEMENT OF DR. J. D. DODD, ASSISTANT DIRECTOR, TEXAS AGRICULTURAL EXPERIMENT STATION, TEXAS A&M UNIVERSITY

Dr. DODD. Thank you, Mr. Chairman, members of the committee.

I appreciate this opportunity to testify about the Native Latex Commercialization and Economic Development Act of 1978. I will briefly describe our past and current guayule research activities in Texas and the future direction and needs of these activities with regard to the act.

Although my presentation will be concerned primarily with the activities in Texas, it is important to recognize that a research network and lines of communication have been established between guayule research scientists and administrators throughout the Southwest. This coordination is a reflection of efforts by the various scientists and the recently formed Guayule Administrative Management Committee.

Research activities within the Texas A&M University system directed toward guayule commercialization can be placed into the following categories: germplasm, agronomics, processing, and infrastructure. These areas of effort are the result of extensive planning at the State, national, and international levels in response to the need for a total systems approach to guayule commercialization through research and demonstration.

Surveys by scientists at the Texas agricultural experiment station have located the major populations of guayule stands native to Texas. A total of 158 plants from 10 different native populations have been sampled and analyzed for rubber content. The average rubber content was approximately 15 percent, ranging from 5 to 20. Three plants from one population were identified that contained 20 percent rubber. Additional sampling from a field established from bulk seed identified a 3-year-old plant with a 15 percent rubber content.

Guayule offers a substantial potential as a new commercial crop in the Southwest. Field research in Texas has been located primarily at the El Paso and Pecos research areas. Seed germination research was initially conducted and resulted in development of satisfactory techniques. These techniques, in conjunction with developed greenhouse technology, now insure a high success rate for the germination and growth of seedlings in the greenhouse for transplanting to the field.

Guayule seeds germinated well under saline conditions—10,000 parts per million dissolved salt—in the laboratory. However, attempts at direct seeding under natural conditions with saline water

were generally unsuccessful when sprinkler or furrow irrigation was utilized. In contrast, when drip or LEPA—low energy precision application irrigation—were utilized, guayule could be established by direct seeding as long as water salinity was below 1,500 parts per million.

Transplant methods utilized in the Southwest have developed to the point that normally a high survival rate can be expected. Survival is also a reflection of soil type, soil salinity, water salinity, and climatic conditions. Field establishment at Pecos from transplants has been successful. Also, guayule seedlings transplanted into sandy soil and irrigated with water containing 3,000 parts per million dissolved salts had a 90 percent survival, but the growth rate was significantly reduced. Field applications of fertilizer produced no visible response.

Seed increase fields have been successfully established at Pecos. The approximately 20 acres includes 6 varieties. Uniform regional variety trials were established at Pecos and Uvalde in 1982.

Insect surveys have noted several pests but have not identified any single species as a dominant.

A basic study of regulation of rubber formation at the cellular level in guayule is underway. Studies have shown that the timely application of bioregulators such as DCPTA will result in an increase in rubber synthesis, even during the summer growth period. Treated plants contained twofold more rubber than untreated plants.

Processing is an important component of the total systems approach to guayule commercialization. Current activities conducted by the Texas Engineering Experiment Station Food Protein Research and Development Center are to develop an efficient, high-recovery process for extracting and purifying rubber from guayule. The process flow scheme consists of five major steps: shrub preparation, solvent extraction, rubber purification, rubber recovery, and solvent recovery.

Byproduct research and identification are important but have not been a major effort. However, a scientist at the station has considered the topic. For example, the rubber industry will gain rubber from guayule, and possible byproducts such as emulsifiers, tackifiers, and solvents that can be utilized within the rubber industry. This also would include the byproducts identified by Mr. Salisbury.

An industrial and agricultural economic feasibility study by the Texas Engineering Experiment Station and the Department of Agricultural Economics of the station has been completed. The initial economic feasibility study was promising and provided substantial support to vigorously pursue the agronomic and associated research needed.

Recently, in 1982, a more detailed economic analysis was conducted for the Texas Winter Garden area, since the national analysis suggested a comparative advantage for this region. With guayule as a production option and a rubber price of 30 cents per pound to the farmer, 2.2 million acres of rangeland would be converted to cropland. Guayule acreage would be estimated at 1.2 million acres.

Guayule has the potential to significantly increase farm net returns. A guayule rubber price of 30 cents per pound or more to the

farmer can be expected to accelerate conversion of rangeland to cropland, and to some degree from cotton and grain sorghum acreage.

Funds authorized by the Native Latex Commercialization and Economic Development Act of 1978 have been important in the development of a total systems approach to guayule research in Texas. These funds have contributed directly to our germplasm and agronomic work. In addition, these funds have indirectly contributed to all other facets of our systems study. This has occurred by utilization of these funds for base studies and as seed money to generate additional funding from other agencies and private industry.

Additional funds for germplasm research were received from private industry. Studies on the regulation of rubber formation are funded by the National Science Foundation. The Department of Commerce provided the initial funding for agronomic work and is now funding extraction and processing research. Additional funds for processing have been received from private and State sources. The industrial and agricultural economic feasibility study was funded by NSF. The detailed Winter Garden study was funded by the Texas Water Resources Institute.

Funds authorized by the act have provided direct support to guayule research and indirectly provided a base that has been instrumental in the acquisition of funds from other sources. Thus, the station scientists have developed, with the base funds available, a total systems study of guayule.

Each segment of the guayule total systems study of the Texas Agricultural Experiment Station has plans to continue and/or expand current research efforts. These plans are dependent upon the availability of base funding for an intermediate time period—4 to 5 years.

Currently, the Texas Agricultural Experiment Station is completing negotiations with the Firestone Tire and Rubber Co. to lease approximately 400 acres of land located on the Firestone Test Track near Fort Stockton, Tex. The land currently supports approximately 200 acres of established guayule of varying ages. The plantings are primarily from bulk seed sources collected from native stands in Texas, Mexico, and bulk varieties from California.

Efforts will be continued to identify germplasm with desirable characteristics such as establishment, growth, and rubber content. Research will be continued and expanded in the areas of direct seeding, seedling establishment, soil and water salinity, seedling mortality, growth and damage, and development of guidelines for irrigation and fertility management. The basic study of regulation of rubber formation will be expanded to regulator studies, including established guayule stands in west Texas.

Research and evaluation will continue in all phases of guayule extraction and processing. This will include equipment evaluation for a pilot plant. The goal is development of process design specifications for a guayule extraction and processing demonstration plant.

Due to the importance of economics to commercialization of guayule, arrangements have been made with those scientists of the Southwest involved in the uniform regional trials to provide data

for refining farmers' costs of production estimates on a continuing basis.

All facets of the Texas Agricultural Experiment Station total systems study of guayule commercialization, in concert with that of the other States—New Mexico, Arizona, California—and with the Agricultural Research Service, will need continued base funding support. This support will encourage and result in a continuation of the cooperative and coordinated guayule commercialization effort in the Southwest. The importance of this support to the effort within Texas has been demonstrated.

In 1978, when the original act received congressional approval, rubber was a foreign-produced material in low supply. This same condition exists today, with a shortfall of over 85 percent in the current strategic stockpile. Extension of the act by Congress would reaffirm the intent and concerns and interest of Congress exhibited in 1978 for this foreign-produced strategic material. Extension of the Native Latex Commercialization and Economic Development Act of 1978 is necessary to provide support to maintain current activity. Additional support will be necessary to accelerate and expand commercialization efforts. This base funding support is needed for an intermediate duration—4 to 5 years—to insure success and survival of the guayule commercialization program.

We recommend that the Native Latex Commercialization and Economic Development Act of 1978, Public Law 95–592, be reauthorized.

Mr. Chairman and members of the subcommittee, thank you for inviting us to present this testimony.

I would like to just add a little sideline if I could. This morning there was reference made to the 4 years on special grant funds. I think it should be noted that we are nearing the end of the third year; there is only one more year left under that particular fund as it is set up currently.

Thank you.

[The prepared statement of Dr. Dodd follows:]

Statement of the Texas Agricultural Experiment Station, by Jimmie D. Dodd, Assistant to the Director

Mr. Chairman, members of the Committees, my name is Jimmie D. Dodd; I am the Assistant to the Director of the Texas Agricultural Experiment Station, which is part of the Texas A&M University System. I appreciate this opportunity to testify before the Subcommittees about the Native Latex Commercialization and Economic Development Act of 1978.

We have been asked to describe our past and current guayule activities in Texas, future direction and needs of these activities, and changes that would facilitate guayule commercialization. Recognizing the abilities and responsibilities of others who will participate in this hearing, I will restrict my comments mainly to the primary focus of our program and plans in Texas. However, it is important that the Committees recognize that our activities, programs, and plans are in concert with those of the other states, New Mexico, Arizona, and California and with the Agricultural Research Service (ARS) of the United States Department of Agriculture (USDA). This overall planned and coordinated effort for guayule commercialization reflects the initial as well as current cooperation and coordination of the scientists involved. These efforts have been recently enhanced and assisted by establishment of the Guayule Administrative Management Committee (GAMC).

The GAMC is composed of one representative from each state (Texas, New Mexico, Arizona, California) and a representative from the Agricultural Research Service (USDA). This Committee was established following a meeting of the Agricultural Experiment Station Directors, Agricultural Extension Service Directors of the four states and Administrators of USDA, ARS, and CSRS in October 1980 at Las Cruces, New Mexico. The Executive Secretary, Native Latex Commission, meets with the Committee.

The Committee, meeting quarterly, serves as a contact between the Joint Commission, the four States and ARS; informs and advises the Directors (SAES and SAEX), and Regional Director, ARS, of guayule activities; defines technical needs of the overall guayule research program; provides liaison with Congressional Groups, Regional Commissions, Commercial Interests, and others; and assists with coordination of guayule research activities between the

various active research scientists.

Currently, guayule commercialization efforts between the various active scientists are well coordinated. As a result, they are in a unique position to make valuable contributions to the guayule effort with the availability of base funding on an intermediate-term basis (four to five years). Baseline data have been collected, and the research network and lines of communication have been established in the Southwest.

PAST AND CURRENT RESEARCH ACTIVITIES

Research activities within the Texas A&M University System directed toward guayule commercialization can be placed into one of the following categories:

1. Germplasm
2. Agronomics
3. Processing
4. Infrastructure

These four general areas of effort are the result of extensive planning at the state, national, and international levels. They also respond to the needs for a total systems approach to guayule commercialization through research and demonstration. The various facets of this total research effort must be carried forward concurrently and with a plan for integration of results to provide the total production technology necessary to exploit guayule as a new crop in the Southwest.

GERMPLASM

Surveys by scientists in The Texas Agricultural Experiment Station have located the major populations of guayule stands native to Texas. Based on the current survey and literature, the number and size of populations have severely declined since 1942. A total of 158 plants from 10 different native populations have been sampled and analyzed for rubber content. The average

rubber content was approximately 15 percent, ranging from over 5 to 20 percent. Three plants from one population were identified containing 20 percent rubber.

Additional sampling has been conducted on selected individual plants in a field established from bulk seed. A three-year old plant was identified with a 15 percent rubber content. Progeny from this plant and the three plants from the native stand are undergoing seed increase, and will be included in observation studies to determine establishment, growth, and rubber content characteristics.

Collections, such as these, are important for the commercialization of guayule. Native stands in Texas provide the only source of wild germplasm in the United States. Collections must be made from these stands and those individual plants of high rubber content must be subjected to seed increase and utilized in trials throughout the Southwest. These individuals may also provide material for a long-term breeding program to develop guayule varieties of high rubber content. A long-term breeding effort, like that in other crops, will result in improved rubber quality and quantity; a prerequisite for initiation, survival, and growth of the guayule industry.

AGRONOMICS

Guayule offers a substantial potential as a new commercial crop in the Southwest. A major effort in agronomic research is underway by The Texas Agricultural Experiment Station scientists. These studies are concerned with all phases, including seed harvesting, seed cleaning, germination, planting and establishment techniques, effects of soil type, environment, water quality, water quantity, methods of water application, plant spacings, insect pests, costs, seed increase, Uniform Regional Variety Trials, and basic studies of rubber formation.

Agronomic research has been located primarily at the El Paso and Pecos research areas. In addition, limited activities have occurred at Uvalde.

Initially, efforts were directed at developing techniques for field harvest and cleaning guayule seed. These techniques, developed in conjunction with other research units in the Southwest, are in use.

Seed germination research was initially conducted and resulted in the development of satisfactory techniques. These techniques, in conjunction with developed greenhouse technology, now insure a high success rate for the germination and growth of seedlings in the greenhouse for transplanting to the field. It has also been shown that pregerminated seeds, used in fluid drilling for direct seeding, can be separated from nongerminated seeds by specific gravity.

Guayule seeds germinated well under saline conditions (10,000 ppm dissolved salt) in the laboratory. However, attempts at direct seeding under natural conditions with saline water were generally unsuccessful. Direct seeding trials by either fluid drilling or by dry seeds were not successful, regardless of planting date, when furrow or sprinkle irrigation was utilized. However, in another trial utilizing drip and LEPA (Low Energy Precision Application) it was shown that guayule could be established by direct seeding. The irrigation water salinity was about 1000 ppm or less. When the water salinity reached 1500 ppm, the seeds germinated and emerged, but mortality was high and growth was reduced. This resulted from plant damage due to soil surface salt accumulations.

Transplant methods utilized in the Southwest have been developed to the point that normally a high survival rate can be expected. Survival is also a reflection of soil type, soil salinity, water salinity, and climatic conditions. Initially, the Pecos area was considered borderline for guayule production due to cold winter temperatures. However, field establishment from transplants has been successful. Results from another study have shown that guayule seedlings transplanted into sandy soil and irrigated with water containing 3,000 ppm dissolved salts had a 90 percent survival rate, but the growth rate was significantly reduced.

Fertility studies have initially shown that guayule has a low requirement. Field applications of fertilizer have produced no visible response.

Seed increase fields have been successfully established at Pecos. The approximately 20 acres includes the following varieties: 11591, 11605, 12229, 11619, N565, N576. A seed harvester was constructed and two harvests were conducted in 1982. Although not all collections have been cleaned, it is estimated that we have over 10 pounds of clean seed.

Uniform Regional Variety Trials were established at Pecos and Uvalde in 1982. In addition, some seedlings were also provided for the USDA/ARS Trials at Weslaco, Texas. The Trials included six varieties (11591, 11605, 12229, 11619, N565, N576). Transplant survival at Pecos and Uvalde was high. Unfortunately, the Trial at Pecos was destroyed by a hail storm after plant establishment.

Insect surveys have not identified any single species as a dominant pest. Several species, lace bug, leafhopper, and lygus bug are potential major pests. A high population of seed weevils was identified. Beetles, moths, and grasshoppers are common as are several beneficial insects.

A basic study of regulation of rubber formation in guayule is underway in The Texas Agricultural Experiment Station. Rubber formation in guayule is apparently associated with stress and this study is designed to identify, at the cellular level, the compounds, including bioregulators, or processes that enhance or block rubber formation. This coordinated research may lead to a relatively simple procedure to provide continuous rubber formation within guayule plants. This would lead to stabilized guayule production.

Under field conditions, rubber is synthesized only during the fall and winter months as the plants experience low night temperatures necessary for rubber induction. In portions of the potential guayule growing region even fall and winter night temperatures may not consistently be low enough to

insure high rubber production. Chemical treatment of guayule with a bioregulator like DCPTA [2-(3,4 dichlorophenoxy)-triethylamine] may make possible the production of rubber from guayule plantings in the potential production area.

Studies have shown that the timely application of DCPTA will result in an increase in rubber synthesis even during the summer growth period. The chemical stimulation was apparent sixty days following application. Treated plants contained a higher total rubber content and a higher percentage of rubber than the untreated plants. The increase was two-fold. An accompanying three-fold increase was measured in the gene products involved in the chemical induction of rubber.

PROCESSING

Processing is an important component of the total systems approach to guayule commercialization. A need exists for reduced processing costs, improved recovery of the final product, rubber, and for identifying high value by-products with a market potential.

Current processing activities, conducted by The Texas Engineering Experiment Station Food Protein Research and Development Center, are to develop an efficient high-recovery process for extracting and purifying rubber from guayule. Laboratory tests are being conducted along with pilot plant evaluation of unit operations required for the various steps in the process. These unit operations will be optimized and a semi-continuous pilot plant will be assembled to integrate the various steps.

The process flow scheme consists of five major steps:

1. Shrub preparation--This includes size reduction, screening and separation, and roll milling. Roll milling appears to give better access to the latex for solvent extraction than hammer milling.
2. Solvent extraction--a one-step extraction using a non-polar

solvent to extract rubber and resins simultaneously is efficient. The solvent utilized is 1,1,1-trichloroethane. A more efficient extraction system than the Crown Iron Works shallow-bed oilseed extractor has been developed.

3. Rubber purification--a satisfactory method to remove dirt and resins has been developed.
4. Rubber recovery--addition of methanol, a polar solvent, to the extracted rubber solution gives the highest rubber recovery.
5. Solvent recovery--tests indicate that the addition of a small amount of water causes the two solvents, trichloroethane and methanol, to form separate liquid phases. This should reduce energy requirements and corresponding costs for solvent recovery.

By-product identification has not been a major effort. However, a scientist of The Texas Agricultural Experiment Station has considered the topic. Products, other than rubber, produced by guayule include resins, bagasse, leaves, cork, and water solubles. Each of these have the potential of providing a valuable salable product. These salable products can contribute to the economics of guayule commercialization. Agricultural crops produce more than one salable product and each contributes significantly to the economic success of that crop. Such an approach must be part of the guayule commercialization effort. For example, the rubber industry will gain rubber from guayule. They also can possibly recover by-products such as emulsifiers, tackifiers, and solvents that can be utilized within the industry.

INFRASTRUCTURE

An industrial and agricultural economic feasibility study by The Texas Engineering Experiment Station has been completed. The agricultural economics section was conducted in the Department of Agricultural Economics of The Texas Agricultural Experiment Station. The agricultural section concluded that the analysis, based on assumption of guayule yield, input levels, and prices for guayule and inputs, indicates that guayule does hold a strong potential as a

viable crop in the Southwest. This means that the economic feasibility study is promising and provides substantial support to vigorously pursue the agronomic and associated research needed.

In 1982, a more detailed economic analysis was done for the Texas Winter Garden since the national analysis suggested a comparative advantage for the region. A model of the region that included an option to convert rangeland to cropland and permit guayule to be produced in competition with other crops and livestock was applied. With guayule as a production option and a rubber price of $0.30 per pound to the farmers, 2.2 million acres would be converted to cropland. This would be 0.8 million more acres converted to cropland than when guayule was not included. Guayule acreage was estimated to be 1.2 million.

Guayule has the potential to significantly increase farm net returns. A guayule rubber price of $0.30 per pound or more to the farmer can be expected to accelerate conversion of rangeland to cropland and to some degree for cotton and grain sorghum acreage.

PAST AND CURRENT RESEARCH SUPPORT

We are appreciative of the support Congress has provided up to this point for guayule research. Funds authorized by the Native Latex Commercialization and Economic Development Act of 1978 have been important in the development of a total systems approach to guayule research in Texas.

Federal funds have contributed directly to our germplasm and agronomic work. In addition, these funds have indirectly contributed to all other facets of our systems study. This has occurred by utilization of these funds for base studies and as seed money to generate additional funding from other agencies and private industry.

Additional funds to support the germplasm research, particularly that portion concerned with the native stand surveys and collections, have been

received from private industry. Studies on the regulation of rubber formation in guayule are funded by the National Science Foundation.

The Department of Commerce, through the Southwest Border States Regional Commission, provided the initial funding for agronomic work. The same agency is currently supporting our efforts in extraction and processing research. The processing effort has also received support from industry and a state agency.

The industrial and agricultural economic feasibility study was funded by the National Science Foundation. The detailed Winter Garden study was funded by the Texas Water Resources Institute.

In summary, federal funds have provided direct support to guayule research and indirectly provided a base that has been instrumental in the acquisition of funds from other sources. Thus, The Texas Agricultural Experiment Station scientists have developed, with the limited funds available, a total systems study of guayule.

FUTURE RESEARCH

Each segment of the guayule total systems study of The Texas Agricultural Experiment Station has plans to continue and/or expand current research efforts. These plans are dependent upon the availability of base funding for an intermediate time frame (four to five years).

Currently, The Texas Agricultural Experiment Station is completing negotiations with the Firestone Tire & Rubber Company to lease approximately 400 acres of land located on the Firestone Test Track near Fort Stockton, Texas. The land currently supports approximately 200 acres of established guayule of varying ages. The plantings are primarily from bulk seed sources collected from native stands in: (1) Texas, (2) Mexico, and (3) bulk varieties from California. The additional 200 acres of land will be available for additional guayule plantings and other arid land plant research.

Acquisition of this site and the accompanying irrigation well and equipment will influence our future research activities. This site will provide a base for germplasm collections, cultural practices, seed collections, and material for extraction, processing, and by-products research. Utilizing this site to its full potential will be governed by the base funding available.

GERMPLASM

Efforts will be continued to identify germplasm of desirable characteristics, establishment, growth, and rubber content. Acquisition of the Firestone site will facilitate selection due to the bulk plantings established and available for analysis. Collection time and cost will be less than that for native stand surveys. Identification of desirable plants will be followed by seed increase to provide adequate progeny for inclusion in all Uniform Regional Variety Trials.

AGRONOMICS

Research will be continued and expanded in the areas of direct seeding; seedling establishment; soil and water salinity; seedling mortality, growth, and damage; and development of guidelines for irrigation and fertility management. Seed harvesting from the seed increase fields will be continued as will the Uniform Regional Variety Trials. The Trials will be expanded to include observation plots of the progeny of the high rubber yielding (20 percent and 15 percent) plants identified in the stand surveys.

Access to the Firestone facility will provide for the following needed activities:

1. Determining the growth and rubber production response of guayule established from bulk seed to various cultural practices (irrigation, tilth, fertilizer).
2. Documenting guayule survival and regrowth rates following pollarding.

3. Determining species and estimating populations of insects that frequent this extensive guayule planting.
4. Determining the phytotoxic effects of selected insecticides for pest control.

The basic study of regulation of rubber formation will continue. Plans are for the bioregulator studies to be expanded this year to include established guayule stands in west Texas.

PROCESSING

Research and evaluation will continue in all phases of guayule extraction and processing. This will include equipment evaluation for a pilot plant. The goal is development of process design specifications for a guayule extraction and processing demonstration plant.

INFRASTRUCTURE

Due to the importance of economics to commercialization of guayule, arrangements have been made with those scientists of the Southwest involved in the Uniform Regional Variety Trials to provide data for refining farmers' cost of production estimates on a continuing basis.

SUMMARY

All facets of The Texas Agricultural Experiment Station total systems study of guayule commercialization, in concert with that of the other states (New Mexico, Arizona, California) and USDA/ARS, will need continued base funding support. This support will encourage and result in a continuation of the cooperative and coordinated guayule commercialization effort in the Southwest. The importance of this support to the effort within Texas has been demonstrated in earlier sections of this testimony.

In 1978, when the original Act received Congressional approval, rubber

was a foreign-produced material in low supply. This same condition exists today with a shortfall of over 85 percent in the current strategic stockpile. Extension of the Act by Congress would reaffirm the intent, concerns, and interest of Congress exhibited in 1978 for this foreign-produced strategic material.

Extension of the Native Latex Commercialization and Economic Development Act of 1978 is necessary to provide support to maintain current activities. Additional support will be necessary to accelerate and expand commercialization efforts. This base funding support is needed for an intermediate duration, four to five years, to insure success and survival of the guayule commercialization program.

We recommend that the Native Latex Commercialization and Economic Development Act of 1978 (PL 95-592) be extended.

Mr. Chairman and members of the subcommittees, thank you again for inviting us to present this testimony.

JIMMIE D. DODD

Dr. Jimmie D. Dodd was appointed Assistant to the Director of The Texas Agricultural Experiment Station, The Texas A&M University System in 1977. Since then, he has been responsible for initiating and operating a Program Development activity with The Texas Agricultural Experiment Station. Dr. Dodd previously had been advanced from Assistant Professor to Full Professor in the Department of Range Science, Texas A&M University. He taught graduate classes, advised graduate students and conducted research in the areas of grassland ecology and vegetation manipulation. He has served on numerous committees for national and international professional organizations. Dr. Dodd is the author or co-author of over 100 publications in scientific journals and book chapters and numerous abstracts on grassland ecology and vegetation manipulation.

EDUCATION:

Training Program in Radiation Ecology, Oak Ridge National Laboratory, Oak Ridge, Tennessee - 1964

Doctor of Philosophy (Plant Ecology - Soil Chemistry) College of Agriculture, University of Saskatchewan, Saskatoon Saskatchewan, Canada - 1960

Master of Science (Botany - Organic Chemistry) Fort Hays Kansas State College, Hays, Kansas - 1957

Bachelor of Arts (Botany - Organic Chemistry) Fort Hays Kansas State College, Hays, Kansas - 1956

Mr. BROWN. Well, I won't go into questioning at this point, Dr. Dodd, but I would just like to comment. Originaly the intent of this act was what you are describing as necessary now. We envisioned a 4- or 5-year program which would culminate in the sufficient planting of guayule to justify a modest processing operation and that it would become a commercial operation at that point.

We never funded it at a level sufficient to do that. We have 4 or 5 years of work behind us, all of it valuable. I think you have an excellent program at A and M, but we still don't have the 10,000 acres planted that we ought to have in order to justify erecting a commercial-size processing plant.

Dr. DODD. Mr. Chairman, I believe we are in a better position, at this point, to put in the 10,000 acres, with the idea that we would provide an adequate demonstration to the producers that it could be economically feasible to produce guayule rubber as a crop.

Mr. BROWN. Yes, I think we are about ready for it, but we will see what Congress decides to do here.

Dr. Niehaus, do you want to tell us all the good things happening at New Mexico?

STATEMENT OF DR. MERLE H. NIEHAUS, DEPARTMENT OF CROP AND SOIL SCIENCES, NEW MEXICO STATE UNIVERSITY

Dr. NIEHAUS. Thank you, Mr. Chairman. I am pleased to testify concerning guayule work in New Mexico.

New Mexico State University began working on guayule in 1976, and increased that level of work after the passage of the Native Latex Act of 1978. The work is being conducted by two scientists, both of whom have other duties such as teaching.

We do have one of the research grants about which much has been said so far today, from CSRS. The one upon which we are working has as its primary objective the establishment of stands. We are comparing direct seeding using various mechanization procedures with transplanting, and we are evaluating several different methods of the direct seeding. The progress in this area has been relatively good and, under certain limited conditions—particularly conditions where the water is low in saline content—direct seeding may be feasible. If you haven't been in New Mexico, you will realize that low wind velocity is important also. We do have some blowouts occasionally.

Also included are comparisons of different methods of weed control, primarily with herbicides. During the emergency rubber production work back in the 1940's, weed control was one of the most expensive parts of growing guayule. This is part of a State project researching guayule. The effect of different methods and amounts of irrigation and the different ways of applying that water are being determined. Also, the effect of different irrigation regimes is being evaluated in terms of seed production as well as rubber yield.

It appears from our work that guayule needs about the same amount of water or almost as much water as cotton the first year, the year of establishment. After that it can get by on quite a lot less, and in terms of survival can get by on practically no irrigation, but in terms of economic production does need to be supplemented under New Mexico conditions, at least.

Now under a separate USDA contract, New Mexico State is increasing the seed supply of six selections of guayule. We have 30 acres planted and seed has been harvested this past growing season. Seed from this planting and a similar planting in California is at least part of the seed being used by the Gila Indian project in Arizona, the project being funded by the Department of Defense.

Mr. BROWN. They are not using the whole $20 million for seed.

Dr. NIEHAUS. No. We sold them 3½ pounds, and California sold them 3½ pounds at $1,000 per pound.

Mr. BROWN. Does that represent a going price commercially?

Dr. NIEHAUS. It is in the vicinity of a going price. It was a negotiated price in this case, one recommended by the Guayule Administrative Management Committee of which I am chairman, so I suppose there could be a conflict of interest there, but it was agreed upon by both parties.

Mr. BROWN. How many pounds does Mr. Anderson have?

Mr. SALISBURY. I don't have it broken down into pounds. I am sorry. If you will give me just a moment, I will check.

Mr. BROWN. I was trying to figure out how much it was worth. Go ahead, Dr. Niehaus.

Dr. NIEHAUS. Regional trials of these same lines are being grown at two locations in New Mexico. I will get into that a little more later, but previous tests have indicated that these selections are the best that we had available from the USDA trials of the 1940's. Therefore, the four States involved plus the USDA are now making official releases of seven lines; six we are growing, and some others are grown in other regional trials. Therefore, seven lines total are to be released. In fact, the release notice is on my desk and should be mailed out Monday, so we can then officially call these "varieties" rather than "selections."

Other research in New Mexico includes the evaluation of rubber extraction methods and the development of botanical descriptions that will be used in future seed certification programs. This work is being done in cooperation with scientists from the other States.

Now my other role in guayule research has already been mentioned, and that is as chairman of the Guayule Administrative Management Committee. This is composed of one person from each of the four States and one person from ARS. It was set up about 3 years ago to coordinate guayule research and to make sure the right problems were being attacked, and that we weren't being redundant. I think it has been a successful venture.

It involves both State and Federal programs, and thus far we have made recommendations and the results are encouraging. The seed increase program followed, at least, the recommendation of this committee. The regional trials which are now being grown, I think, at 10 locations across the 4 States, have followed recommendations from this committee. An ARS scientist has been assigned half his time to act as a regional research coordinator of guayule research and development activities at both the State and Federal levels; he is located in Phoenix. We are also instrumental in the process by which these seven varieties are being released. This committee meets about four times per year and either Dr. Dodd—beside me—or myself have attended a majority of the Joint Com-

mission staff meetings and some of the Joint Commission meetings that have been held since this group was formed.

My personal opinion is that guayule has the potential to become a competitive crop. However, much research and development work remains to be done. It is not a domesticated crop. We are trying to grow a crop that grows wild in the desert, so it is a little different than improving corn and wheat. Improvement is slow and difficult, but I think current studies show that improvement is possible.

The proposed CSRS budget for next year, fiscal year 1984, has no money for State experiment station guayule research. That means that, at least in New Mexico, after the next year's funding on these competitive grants runs out we will virtually cease guayule research at the State level. We do put State money into guayule research, but it would not be enough to continue our program without the supplemental Federal funding.

The primary need for a successful improvement program is a sustained, dependable source of funds. The amount of funding is important but, in my opinion, even more important is the dependability of those funds. It is very difficult to build a good research program on funds which are allocated 1 year at a time, particularly with the possibility of losing the funds ever-present. If the extension or the reauthorization of the act about which we have been talking can provide dependable funding for 4 or 5 years, then I am for that reauthorization.

Thank you.

[The prepared statement of Dr. Niehaus follows:]

Las Cruces, New Mexico
Mar. 17, 1983

Guayule Research in New Mexico

Guayule (Parthenium argentatum) is a shrub native to Mexico and part of the U.S. southwest. It can be grown in Texas, New Mexico, Arizona and California. It produces a rubber virtually identical to natural rubber from Hevea rubber trees.

The rubber is found in the stems and roots of the plant. The best harvest schedule is not yet known but harvesting three-year-old plants with major roots included appears feasible. The rubber must then be extracted from the plant.

The best method of establishing the crop is also not yet determined. Most present fields have been established by starting plants in the greenhouse and then transplanting the individual plants to the field. Direct seeding is also being investigated.

Seed production is poor and seed is difficult to harvest. A vacuum harvester has been developed but improvement is still needed.

The best method of developing new varieties has not been determined. Seed is produced by a process called apomixis and chromosome number is variable. Both characteristics cause breeding improvement to be slow and difficult.

Yield level of material now being tested in New Mexico is too low for profitable production. Yields must be improved or the price of the rubber must be significantly higher for the crop to be competitive. Most researchers agree that there must be an increase in the percent rubber in the plants of new varieties. Fortunately, plants with higher rubber percentage have been found.

Cultural methods including date and method of planting, amount and timing of irrigation, method of weed control, soil fertility, method and time of harvest, use of growth promoting chemicals, and method of extraction all need to have more research. Guayule is a new crop which has good potential, but sustained developmental work over a several year period is needed to make it a competitive crop.

Researchers in Texas, New Mexico, Arizona and California are working on guayule and improvement is being made. However, much more work is needed before guayule can be considered a domesticated crop.

The following discussion pertains to research being done in New Mexico. There are several different projects being conducted by two faculty members each of whom also has other duties.

1. Influence of Establishment Methods and Herbicides on Guayule Rubber yield.

Various methods of establishment, primarily direct seeding and transplanting, are being evaluated. Also, several herbicides are being compared for their effectiveness in controlling weeds and their direct effect on rubber production.

In order to expand the area of production for guayule (areas of New Mexico where rainfall is adequate for dryland production) it must grow and produce in areas having colder winters and establishment must occur during cold weather. To obtain the genetic variability for this trait crosses with related cold tolerant species are being evaluated.

2. Effects of Parasitic Nematodes on Guayule Rubber Production.

Research is being conducted to determine the effect of nematodes on rubber yield. Nematodes found on guayule roots are being identified and control measures are being developed.

3. Guayule Production.

Irrigation levels in combination with method of establishment are being evaluated to determine their effect on rubber yield. Various traits are being measured including seed production, yield of biomass, rubber percentage, rubber yield, plant survival and resin content.

4. Seed Increase.

Thirty acres of guayule are being grown near Las Cruces, New Mexico in an effort to produce seed for further research and commercialization efforts. Seed was harvested in October of 1981 and in June and October of 1982.

Seed from this planting was sold to the Gila Indian group in Arizona for their production fields. This planting will be part of a Department of Defense contract to produce large amounts of rubber for testing.

The present status of the seed increase planting is that it will be abandoned shortly without new funding. It is on rented land and the rental fees and the cost of irrigation are greater than the funds available.

5. Regional Yield Trial.

A replicated yield trial with either six or seven guayule selections is being grown in several locations in each of the four states where guayule is adapted. The purpose of the trial is to determine the area of adaptation of each of the presently available lines and to determine the rubber yields which might be expected.

The seven lines are in the process of being released as varieties in order to accelerate the commercialization of guayule. (Descriptions of these lines are presented as Appendix A).

Guayule research in New Mexico is supported by U.S.D.A. and state funds. These funds amounted to approximately $100,000 during FY83 with the majority from U.S.D.A.

In order for the research to continue, U.S.D.A. funding is mandatory. State funding is not available at the level required to continue the research. More funding is needed to accelerate progress but perhaps of more importance is constant funding which can be depended upon for more than one year at a time.

Results thus far indicate that there is potential for guayule production in New Mexico. Much more needs to be known about the crop and yields must be improved to make it competitive.

It should be noted that on two previous occasions guayule research became a high priority and much research was begun. Much of this research was never completed because decisions were made that eliminated research funding. The two occasions were WWII and the Korean War. It would be unfortunate if this were repeated again.

Merle Niehaus
Chairman, Guayule Administrative Management Committee
Head, Crop and Soil Sciences Department
New Mexico State University

APPENDIX A

NOTICE TO GROWERS OF THE RELEASE OF SEVEN CULTIVARS OF GUAYULE

The Agricultural Experiment Stations of Arizona, California, New Mexico and Texas, the Agricultural Research Service and the United States Department of Agriculture jointly announce the release of seven cultivars of guayule. These cultivars are N-565, 11604, 11619, 11591, 11605, 12229, and N-576.

These seven cultivars are a part of the 25 germplasm lines and selections that were stored at the National Seed Storage Laboratory at Fort Collins, Colorado, in 1965 after the USDA guayule breeding program at Salinas, California, was closed out in 1959. The 25 germplasm lines and selections were saved from hundreds of selections and cultivars on the basis of rubber production and other outstanding characteristics at Shafter and Salinas, California, during the 1950's.

The seven cultivars were selected by a committee representing California, Arizona, New Mexico, and Texas on the basis of their expected overall adaptation and performance in all four states. Selection criteria consisted of characteristics such as cold tolerance, plant uniformity rubber yield, rubber percentage, growth characteristics, seed production, stand establishment and availability of seed.

Data on rubber yield and rubber percentage available from the four states were considered as very preliminary because it was on the basis of the first harvest on 2-year old plants. However, yield test data now available on 2-year old and 3-year old plants essentially confirm that the right selections were made using the preliminary data (Tables 1 and 2). The old standard line 593 from the World War II Emergency Rubber Project is included in the tables as a standard of comparison.

The breeding behavior of guayule is somewhat different than many standard agricultural crops because it is a perennial and its mode of reproduction is by apomixis rather than the ordinary sexual process. In apomixis the seed actually arises as a maternal clone rather than from fertilized eggs. In guayule apomixis is facultative which means that a small percentage of the seed may be from fertilized eggs. The amount of apomixis in these seven cultivars has not been determined; however, they are all very highly apomictic.

The pedigree and history, certain unique morphological characteristics, other identifying features or characteristics, and relative performance in rubber production of the seven cultivars in the Seed Increase Program are given below: (See Tables 1 and 2 for performance data on rubber yield and percent)

1. N-565 -- It is an open-pollinated cross from strain S1811-206 which originated from 4265-I. It was a very high yielding selection in a 2-year old USDA yield test at Shafter sampled in 1957. In Arizona and New Mexico plantings it has a plant uniformity rating of 94%. In morphological features it is rather unique, being more bushy and denser branching, and it has more serrated leaves and is later in flowering than the other six cultivars. In yield tests of 3-year-old plants with 23 cultivars at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 5th, 11th and 11th in pounds of rubber per acre and had a rubber percentage of 7.3, 6.2, and 8.4, respectively.

2. 11604 -- It is an open-pollinated selection from 4265-I with no yield information available from old USDA tests. In Arizona and New Mexico plantings it has a plant uniformity rating of 90%. Ir morphological features its leaf type is similar in shape and serrations to selection 11605, but its more erect growth habit is similar to 11591. In yield tests of 3-year-old plants with harvest of 23 lines at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 14th, 6th and 1st in pounds of rubber per acre and had a rubber percentage of 5.5, 4.8, and 8.4, respectively.

3. 11619 -- It is an open-pollinated selection from 4265-I and was high in rubber yield in the USDA yield tests at Salinas in the 1950's. In Arizona and New Mexico plantings it has a plant uniformity rating of 80 to 95%; however, it appears to be more uniform than that because the off-type plants are very small. It is similar to 11591, 12229, and N-576 in morphological characteristics. In yield tests of 3-year-old plants with harvest of 23 lines at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 13th, 2nd, and 8th in pounds of rubber per acre and had a rubber percentage of 6.6, 6.6, and 7.3, respectively.

4. 11591 -- It is an open-pollinated selection from 4265-I and was a high yielding selection in USDA yield tests at Salinas in the 1950's. In Arizona and New Mexico plantings it has a plant uniformity rating of approximately 95% and is very similar in morphological characteristics to 11619, 12229, and N-576. In yield tests of 3-year-old plants with harvest of 23 cultivars at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 4th, 15th and 19th and had a rubber percentage of 4.4, 3.4, and 7.0, respectively.

5. 11605 -- It is an open-pollinated selection from 4625-I and a high rubber yielding selection in the USDA yield tests at Salinas in the 1950's. In Arizona and New Mexico plantings it has a plant uniformity rating of 70% which means that it is a variable selection in height and morphological characteristics. In yield tests of 3-year-old plants with harvest of 23 lines at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 7th, 20th, and 10th and had a rubber percentage of 6.8, 4.4, and 8.4, respectively.

6. 12229 -- It is a third generation open-pollinated selection from a multiple cross of a 36 chromosome guayule x Parthenium tomentosum and then crossed to 4265-Ig. It is an individual open pollinated plant selection S2636-168 from plant selection S1875-143 from selection 2106 which came from the multiple cross. It was a high rubber yielding selection in a 2-year old USDA yield test at Shafter in 1958. In Arizona and New Mexico plantings it has a plant uniformity rating of approximately 95% and is similar to 11591, 11619, and N-576 in morphological characteristics. In yield tests of 3-year-old plants with harvest of 23 lines at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 10th, 13th, and 24th in pounds of rubber per acre and had a rubber percentage of 5.3, 4.4, and 6.0, respectively.

7. N-576 -- It traces to a plant selection made at Salinas from Collection A48116 on the basis of higher rubber yield than check lines 4265-X and 593. In Arizona and New Mexico plantings it has a plant uniformity rating of 95% and it is similar to 11591, 11619, and 12229 in morphological characteristics. It has a larger seed size and higher seed yields than the other lines. In yield tests 3-year-old plants with harvest of 23 lines at Tucson and 22 at Mesa, Arizona, and 26 at Las Cruces, New Mexico, it ranked 16th, 12th and 16th in pounds of rubber per acre and had a rubber percentage of 5.6, 4.9, and 7.1, respectively.

Table 1. Guayule line performance at different locations and time of harvest.

Cultivar	Rubber yield in lb/acre						Percentage rubber content					
	Location and age of plant											
	Tucson, AZ		Mesa, AZ		Las Cruces, NM		Tucson		Mesa		Las Cruces	
	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr
N-565	1643[2]	1994[5]	448[12]	1260[11]	351[10]	852[11]	7.2	7.3	5.6	6.2	7.5	8.4
11604	1873[1]	1318[14]	642[2]	1438[6]	482[2]	1289[1]	5.3	5.5	5.1	4.8	6.9	8.4
11619	1236[12]	1322[13]	507[7]	1690[2]	310[15]	946[8]	5.3	6.6	6.6	6.6	7.4	7.3
11591	1040[17]	1999[4]	455[11]	978[15]	365[7]	772[19]	3.5	4.4	4.3	3.4	6.8	7.0
11605	1546[3]	1803[7]	458[10]	683[20]	502[1]	890[10]	5.9	6.8	5.8	4.4	8.1	8.4
12229	996[19]	1528[10]	412[16]	1026[13]	306[16]	571[24]	4.2	5.3	4.6	4.4	6.5	6.0
N-576	1128[15]	1246[16]	309[19]	1048[12]	374[5]	795[16]	3.4	5.6	4.3	4.9	6.9	7.1
593	983[20]	1082[17]	422[15]	726[19]	302[18]	672[21]	3.7	4.4	4.1	4.4	5.9	6.5

Superscript refers to ranking of lines in yield of 23 at Tucson, 22 at Mesa and 26 at Las Cruces. Of ten lines tested at Pecos, Texas, yields sampled after 26 months ranked 11605 1st, 11604 sixth, 593 seventh, and 12229 tenth.

Table 2. Average of guayule line performance at three locations and time of harvest[1].

Cultivar	Rubber yield in lb/acre		Percentage rubber content (dry wt. basis)	
	2nd year	3rd year	2nd year	3rd year
N-565	814	1369	6.8	7.3
11604	999	1348	5.8	6.2
11619	684	1319	6.4	6.8
11591	610	1250	4.9	4.9
11605	835	1125	6.6	6.5
12229	571	1042	5.1	5.2
N-576	604	1030	4.9	5.9
593	569	827	3.9	4.4

[1] Average of plantings at three locations; Tucson and Mesa, Arizona, and Las Cruces, New Mexico.

Mr. BROWN. Thank you very much, Dr. Niehaus.

I have noted in long experience here that researchers always feel that there is a need for more research. I feel that they are right, of course, but it is remarkable how perceptive they are about it.

Dr. NIEHAUS. Consistent.

Mr. BROWN. We are moving westward, and we have reached Arizona. Dr. Rubis, do you want to give us a report?

STATEMENT OF DR. DAVID RUBIS, DEPARTMENT OF PLANT SCIENCES, UNIVERSITY OF ARIZONA

Dr. RUBIS. Thank you, Chairman Brown. I am very pleased to have been invited here to give you testimony on guayule, because I believe that guayule has a tremendous potential, first as a new crop, very important as a domestic source of natural rubber, and a new domestic industry.

My comments to you today are as a scientist, as a plant breeder, a geneticist, an agronomist, and one who has worked with guayule for the past 7 years. It is a good thing we are all giving testimony because we hit different points. I would like to review some of the things that we have worked with, particularly as a plant breeder, in developing guayule, and some of my experiences with it.

I have also had many visitors from foreign countries who have come to confer about guayule, and I have personally visited programs in Mexico, Israel, Australia, and South Africa. I notice this subcommittee is on international agriculture, and we might want to make some comments on that later.

Today I would like to review the guayule program in Arizona during the past 7 years. I want to review that in the context of two phases: There was a first phase in which we started in 1976 to 1980, in which we got guayule going; then since 1980, in which a lot of these activities have been funded by the Native Latex Act; and then where we are now in our particular current research.

Starting back in 1976, the National Science Foundation funded us to make big germplasm collections in Mexico, and then we made further collections in 1977 and 1979. We have a very extensive germplasm bank. We haven't used it to a big extent but we are evaluating it so as to know how to use it and where we need it.

Then, among the germplasm, of course, were the 25 USDA lines that were tested as some of the best material during the fifties up until 1959, and after the guayule was terminated in 1959. In 1960–61 they increased the seed in Salinas and sent it to the National Seed Storage Laboratory at Fort Collins. Of course, we increased that seed in 1976 and then provided seed to others from that. In fact, some of the first seed that went to New Mexico and some of the other places was from what we increased. We also increased it to get yield tests going.

Our funding from 1977 to 1979 in carrying out this program was from the Four Corners Regional Commission, which is a part of the Department of Commerce. There was some mention of that this morning, that part of some of the funding of the Department of Commerce came through the Four Corners Regional Commission and it was funded as seed money to begin new industry, I mean, under that context.

Under that program we planted some yield tests, we started out some water tests, and particularly yield tests to identify what types of varieties were adapted to different areas, and also studied establishment methods. In fact, I would say that during this first 7 years much of our efforts have been toward how to establish guayule, and I think we have come a long way.

I think that if we had to produce 20,000 or 40,000 acres, we could come up with a very good program in which we could do that, and a very good method where in each year we would come up making it more economical. At the present time we would have to do this under transplanting methods because we could guarantee a 99 percent establishment. We are continuing research and looking at all different ways of watering, direct seeding, cost-wise and so on, but right now we have a good transplanting system.

The four corners funding was terminated in 1979, and at that time the National Science Foundation provided funding for continuation of some of the projects that we had started under the four corners program. When the Native Latex Act was implemented, then the 3-year projects that were under NSF were terminated after a year or a year and a half in such a way that the Native Latex Act took up the funding of these particular projects.

The point I wanted to make was the fact that the research that is going on under the Native Latex Act is really the projects that had been begun before that. And the act is such an essential part of all this funding and all these programs that are going on. I don't know, if it didn't continue funding as was mentioned before, would these things terminate, or do we have to beat the bushes for other places to keep it going?

The Department of Agriculture this morning mentioned the amount of money that went into the guayule. They did not mention the indirect funds that go into it, that come down to the experiment stations, which pay my salary, etc. That wasn't in there, so that there is actually money that comes through the experiment stations that is part of that funding, that is really part of the Department of Agriculture that didn't get mentioned this morning.

Therefore, this is sort of the first phase before the Native Latex Act. We did get germplasm. We did get some yield tests going. We started the cultural tests. We started collecting seed, and when the Native Latex Act started we were into the process so that we could really get good research going.

The next part of it that I want to mention, then, is that with the implementation of the Native Latex Act of 1980 there were four projects that were funded at Arizona that had to do with the improvement of guayule, particularly using our germplasm collections, water use and cultural practices, disease identification and control, and then commercial seed production practices. Later added to this as an adjunct project was the seed increase of the best varieties and the genetics material development program added in 1981. These projects have encompassed the main agricultural research on guayule that actually is conducted by three different departments—plant sciences, soils, water, and engineering, and plant pathology—within the College of Agriculture.

There are other projects at Arizona that are funded by NSF. There are grower groups that are doing work. A lot of our work is

carried on at the Goodyear Farms at no expense whatsoever to us. In fact, they provide all the same facilities that our experiment stations do, the water and so on, at no cost to us, and we have the land to carry on work, so there is commercial cooperation.

Now at the present time in our current projects we have a number of long-term experiments that we don't have results from, but we have results from some of these that began earlier and were continued with the Native Latex Act. I would like to summarize the highlights of some of those under three points or three different groupings: One, the production practices and variety testing; second, seed increase and seed production; and, third, breeding.

Under production practices and variety testing, we have continued the yield tests. We established new procedures and greenhouse procedures. In fact, one of our best innovations was our greenhouse procedures. The fact that we raise seedings, or rather the fact that they are ready at, say, 7 or 8 months and we have to hurry to get them put out in the fields. Now we clip back these seedlings and we can hold them any length of time. I have some that are over 2 years old that are ready to plant if we want to. So, we can start these in a greenhouse, maintain them under less costly facilities, and plant them when we need to, and they are very strong seedlings that way.

We have had about equal success with sprinklers and furrow irrigation in establishing transplants. So I think we—as I said before—could come up with some good commercialization in establishing guayule.

In the yield tests we have established a method of rubber analysis and there have been several people that have had different rubber analysis. As some of the rubber analysis is different, this is one of the parts in our basic research, where we need to come up with an analysis that is standard between the States so we can have better comparisons.

We have continued to do work on the water use and irrigation, and of course we have found that we have higher rubber under low-water regimes than we do under higher regimes; however, under the higher regimes we do have more rubber per acre. I have a test going now in which I want to show the production of absolute rubber per area and the amount of water used as the seasons go on. I think others are playing a percentage game.

The yield test that we first planted in 1978, have been harvested after 2 years, after 3 years, and after 4 years. From these tests we have shown that we had an average of about 6-percent rubber in the better varieties and we produced about 600 pounds of rubber per acre per year. The surprising thing was that we produced the most rubber in the first 2 years, and after 3 years the accumulation of rubber sort of leveled off. We had always been led to believe that we had to raise this crop 4 or 5 years, and I think this is probably the first yield tests that have really showed the facts.

We have never had continuous yield tests to get some of this data before. In the emergency rubber project they were started and discontinued after 3 years. After that there were some other experiments started, and they had data up to 2 years and 3 years. It has always been thought to be this, but I don't know of any good

data that shows yields after 3, 4, and 5 years and so on. These are the first ones we have.

With this data we have also begun clipping experiments in which we start clipping back the plants after a year and a half, 2 years, and so on, and getting regrowth. Our indication there was that if we clipped back after a year and a half, that the next year and a half we could get almost that much growth again. Therefore, with this type of work I think we have initiated a lot of clipping experiments in other States—New Mexico, Texas, California. This is something that has come along more or less with other phases of research and we feel that we could probably go to about 2 years or so and clip back and get another crop. We save the cost of the reestablishment, and we have a more continuous production of guayule coming into a processing plant. Therefore, I think that this is one of our achievements in the last several years under the Native Latex Act. It is a better production practice which could be more economical.

In regard to the seed increase, as mentioned by the previous speakers we have our seed increase project with what we considered our seven best varieties. These have been very useful to us because we are using the field to try our cultural practices, fertilizer tests, and irrigation test. Then, I am also using the field to do various research on seed production practices, particularly mechanization. Besides the engineers building a seed harvester, we are looking at machinery to thresh the seed, to clean the seed, and to come out with clean seed and so forth. Later the germination tests the quality of that seed. Therefore, these are some of the things in progress.

Our first 20 acres of six varieties were planted at Marana in 1981. In the year 1982 we had about 30 pounds of clean varietal seed obtained from those 20 acres. We actually missed our first crop in May; a rainstorm shattered it out before we got it, and that is really when the best seed is produced. Of course, these fields will be used for seed harvest this year in which we should be able to make a good seed stockpile from them.

In the breeding and genetic project, we are growing the 26 varieties out in larger plots, using them as a yield test that is comparable to the other regional variety tests. In fact, I just harvested them last week. You can see the blisters on my hand there as evidence. I am really very pleased at the way they are coming out and the amount of growth we have after only 14 months. That seed will be increased so we could replenish the seed that everybody has been using out of the seed storage laboratory at Fort Collins. Thus we will have seed available for any other tests that we have, or for other countries or for whatever our needs.

Much of the effort on the breeding has been to determine the breeding behavior of guayule. I have planted plant progenys from some of the better varieties, and from the extra-large, fast-growing plants. One of the things that we have come up with in guayule that I would say is a breakthrough in the breeding of guayule, in this past year. Guayule produces seed by the process of apomixis; this means that seed is produced in a vegetative process rather than a sexual process. Of course, a lot of breeders say this is unfortunate because we can't make crosses to produce new types. How-

ever, we have found that certain lines produce a number of what we call haploids, very minature-size plants that only have half the chromosome number. These we can use as females to make crosses from any guayule line, and the progeny we get back have the normal number of chromosomes. Of course, what we really have is an F1 hybrid, and it is apomictic and it is self-reproducing. Since my days in graduate work back in 1948 at Iowa State, my advisor at that time said, "If we ever find a way that we can produce an F1 hybrid and it would be self-reproducing, that would be Eureka."

Therefore, we have it in guayule. In this case here, not only are we improving guayule, but are discovering basic things out of guayule, which, we can probably use in other crops. Therefore, this has been a very interesting discovery that has come about.

We just have some of the first progeny from haploids, and I think the system will work. Of course, I am very anxious to really get going on this system, and to get the type of funding with which we can really push on it. With this system and the interspecific crosses that are coming along, I would not be surprised that in the next 4 or 5 years, we certainly would double the yields of guayule or better.

Therefore, I think that the last several years have really brought something about, which is right on the surface of going somewhere. This is, I think, is what you are hoping for to come about, and I think it can.

At this hearing, I would like to particularly emphasize the extreme urgency to continue the funding of guayule commercialization. Only in last month's issue of the "Natural Rubber News" from the Malaysian Rubber Bureau, the prediction is for a shortfall of hevea by 1989 to 1990. We first experienced that in 1979, and if we had not had the recession, we would probably be in a shortfall of hevea now. However, if there is a shortfall of hevea rubber in 1990, where do we go?

I just recently came back from a trip last October, to South Africa, and their options there are that they would use synthetic polyisopreme made from coal, or grow guayule. Two commercial companies have made a feasibility study on the synthetic polyisopreme, and they said, "Well, we will have to put a 60-percent tariff on hevea so we could compete."

Therefore, if we are going into a shortfall of hevea by 1990, then we should be looking at that right now, because what are we going to do then, when we don't have enough hevea? We will have to speed up guayule development, and we can't speed up breeding. We can't stop and then speed it up. Breeding takes time. We can't buy time. There is just no substitute for it. Therefore, I would like to emphasize the urgency now.

The other part that I would like to emphasize—and I have spent a career of 30 years on developing new crops, and have worked with a lot of oil seed crops and so on—in working with new crops, we look at germplasm, we look at breeding, and then we go to the commercial processing and the consumer, and we want to know what is coming off on the other end. The breeding can often solve some of the processing problems.

I believe very, very strongly that we need a research pilot processing plant at the present time. Now that we know how to estab-

lish guayule, we want to know how to harvest it. We need a processing plant to know how we are going to take it out of the field, and in what type of a form the processing plant is going to use it, and then whatever they need, we can probably produce this by breeding.

Another point, we are using a lot of interspecific crosses to improve guayule. They had a processing plant, a research processing plant, from 1950 to 1953 in Salinas. Dr. Taylor ran it at that time, and I talked with him about it. He said one thing that he wanted to emphasize was that if we are producing new varieties from interspecific crosses, we need a processing plant to process these varieties, to know how they are going to process. We can run rubber in the laboratory, and we get a rubber percentage, but when we put it through the processing plant, some of these varieties came out like mud rather than rubber.

I had experience in safflower in developing varieties. In fact, the highest oil percentage safflower we ever produced, the commercial industries wanted it and I gave it to them. We planted it out and they were ready to go to a lot of acres, and I said, "No, this thing stinks." In fact, it had a wet straw smell. I said, "Well, we have to try it first and process it." They said, "Well, don't worry about it. In processing, with chemistry, we can take care of anything; we can deodorize that." They processed it in a pilot plant, they deodorized it; and 6 months later, on the shelf, it was stinking again. We have never grown it, but we stopped it at 200 acres.

Just from that experience, I feel that the breeding, and a research processing plant are needed at the same site, wherever guayule is grown. I guess we'll let the Congressmen fight it out, whether that is in Texas or in New Mexico, or in the middle, where it is closest to everybody, in Arizona, or in California next to Riverside—but I think that we ought to have one. I did want to point that out.

I think that I have jabbered enough. I thank you people very much for having me here to give you my views on guayule. I, myself, have worked on it for 7 years and I am intrigued with all the different, new crops that I have worked on, but especially the terrific potential of this one, guayule.

I think the other thing I could point out is the fact that most of the work that was started on guayule was started before the Native Latex Act. This work was started by people that are dedicated to guayule. The fact that this Native Latex Act is now supporting these projects—we aren't working because there was funding money—we are working because we are interested in guayule.

Thank you very much, Mr. Brown.

[The prepared statement of Dr. Rubis follows:]

Testimony Concerning

GUAYULE

by

Dr. David D. Rubis

Professor of Plant Sciences
University of Arizona
Tucson, Arizona 85721

and

Principal Investigators and Co-Investigator on USDA-SEA
Cooperative Research and Special Programs Projects:
Seed Production Practices for Guayule Commercialization.
Guayule Seed Increase Production and Genetic Materials Development Program.
Guayule Improvement Utilizing the Arizona Germplasm Collection.

Before a session of

Subcommittee on Science, Research, and Technology
of the
House Committee on Science and Technology
and
Subcommittee on Department Operations, Research, and Foreign Agriculture
of the
House Committee on Agriculture

Oversight Hearings on PL95-592
The Native Latex Commercialization and Economic Development Act of 1978

March 24, 1983

Honorable Congressman George E. Brown Jr. and Honorable Congressman Doug Walgreen, Members of the Subcommittee on Science, Research and Technology of the Committee on Science and Technology, and Members of the Subcommittee on Department Operations, Research and Foreign Agriculture of the Committee on Agriculture:

I am pleased to have the opportunity to discuss guayule with you today because I believe that guayule has a tremendous potential as a new crop, as a new domestic source of natural rubber, and a new domestic industry.

My comments to you today are that first, as a scientist, more specifically a plant breeder, geneticist, and agronomist; and secondly as one who has been involved during the past seven years in research, development, and commercialization of guayule. Besides being involved in many planning meetings on both the local and national levels, I have been involved directly in all facets of growing the plant and particularly in developing machinery, cultural practices, and breeding methods. I have had many visitors from foreign countries who had come to confer about guayule and I have personally visited guayule programs in Mexico, Israel, Australia, and South Africa.

Today, I would like to give you a brief review of the guayule program in Arizona during the past seven years, a discussion of the current programs in progress, and my perspective of the future direction necessary for guayule.

First, I will briefly review the work begun from 1976 to 1980 before the implementation of the Native Latex Commercialization and Economic Development Act of 1978 (henceforth called the Native Latex Act). Under the National Science Foundation (NSF) program we made extensive germplasm collections in Mexico during 1976, 1977, and 1979, including related Parthenium species. From these collections we have established germplasm nurseries at Yuma, Mesa, and Tucson for study, evaluation and seed increase. The 25 USDA varieties were obtained from the National Seed Storage Laboratory at Fort Collins in 1976 and were planted at Mesa for seed increase. Seeds from this nursery were used to plant yield tests in Arizona and other states. With funding from the Four Corners Regional Commission (Four Corners) in 1977, a Guayule Research and Development Project was established in Arizona, New Mexico, and Nevada. Under the Four Corners project we established yield tests in four locations in Arizona and developed techniques for threshing and cleaning seed. The development of a mechanical seed harvestor was also begun. We developed the first methods for field establishment of guayule, including greenhouse production of transplants and mechanical equipment for transplanting. Work was also begun in disease studies. The funding under the Four Corners Project was terminated in 1979. At that time, the NSF provided funding for a breeding and genetics project and for a project on water use and production practices. Work under these two projects was continued in 1980 by the Special Grants Program under the Native Latex Act.

With the inplementation of the Native Latex Act in 1980, four projects under the USDA-SEA Special Grants Program were funded at the University of Arizona. Work under these projects continued much of the research which was previously started under the Four Corners Project and the NSF and also included new objectives. These four projects are involved with (1) improvement

of guayule using the germplasm collections, (2) water use and production practices, (3) disease identification and control, and (4) commercial seed production practices. A project for the seed increase of the best varieties and a genetic materials development program was added in 1981. These projects encompass the main agricultural research on guayule and is conducted within three department -- Plant Sciences; Soils, Water, and Engineering; and Plant Pathology -- within the College of Agriculture. There is close cooperation among all the projects.

There are many experiments and special studies conducted under all of these projects. Many are long term experiments of which we do not yet have results. However, there are results from some experiments started before the Native Latex Act which have now been completed and there are results from short term studies all of which are most interesting. I will point out the highlights of these accomplishments under three main headings, (1) production practices and variety testing, (2) seed increase and seed production, and (3) breeding guayule to improve the economics.

Much of our efforts to date have been directed toward the development of field establishment practices, cultural practices, and variety testing. We are now able to accomplish field stands of 99% and better. This is with improved greenhouse procedure to produce stronger transplants and with better irrigation procedures, both with sprinklers and furrow irrigation. We found that we could produce stronger transplants by clipping and regrowth. We have developed a method of rubber analysis simulating processing procedures and have set up a rubber analysis laboratory to help evaluate all experiments. Irrigation studies have shown that the highest rubber percentages are obtained under low water regimes but that the most total rubber is obtained under higher regimes. Plots from the yield tests planted in 1978 have been harvested after two years, after three years, and after four years. The greatest accumulation of rubber occurred during the first two years and the increase had leveled off after three years. The better varieties have about six percent rubber and produce about 600 pounds of rubber per acre per year. There were extreme variations due to soil types, locations, methods of planting, and varieties. Much of this was due to very small sample plots. However, information from these tests is invaluable in designing new improved yield tests. We were surprised at the leveling off of rubber accumulation after three years because we were led to believe by many previous workers that this would occur after four or five years. The data from our experiments are the first data of this kind to indicate what does happen. These results have led to the initiation of a number of clipping experiments by which the plants are clipped back after 18 to 30 months and new production occurs from the regrowth. We already have indications that this practice would greatly increase total rubber production on a per acre per year basis over a period of time. This should greatly improve the economics of production.

Seven of the better varieties on the basis of rubber production, rubber percentage, cold tolerance and growth characterists are a part of a seed increase program. Twenty acres of six varieties were planted at Marana in 1981 and over 30 pounds of clean varietal seed was obtained from several harvests in 1982. This is enough seed to plant back about 500 acres. The 25 USDA varieties were planted in one-sixth acre plots in Tucson for seed increase

and yield testing. The seed will be used for further increases and for re-stocking the National Seed Storage Laboratory at Fort Collins. The seed production fields are also being used for developing cultural practices for irrigation and fertilization; and for developing machinery and equipment to harvest, thresh, and clean seed. The engineers are redesigning and improving on the fourth model of the mechanical seed harvester. Several machines have been modified for threshing and cleaning seed. Further progress is needed. These seed production fields have also provided the opportunity to study plant diseases, which so far have not been a big problem. However, several germplasm lines are very susceptible to some diseases and these are being identified. A program has been developed to screen for Verticillium wilt resistance. In the Seed Increase Program we have worked with the Arizona Crop Improvement Association in developing standards for producing certified seed of guayule varieties. In the commercialization of guayule, this will assure growers that good quality seed will be available of varieties that produce good quantity and quality of rubber.

In the genetics and breeding project several hundred plant-progenies have been planted in 1982 and several hundred more will be planted in 1983. Many of these selections were extra-large, fast growing plants which occur infrequently in some varieties but most were a re-selection program within the best varieties. Much of the effort todate has been spent on determining the breeding behavior of guayule in order to set up breeding methods. Guayule produces seed by the process of apomixis, this means that seed is produced by a vegetative process instead of by the sexual process. Most breeders consider this a handicap because it prevents crossing to produce new types. However, I consider this a great advantage because guayule plants which are very heterozygous will reproduce themselves true to type like cloning. We have had a big breakthrough in the breeding of guayule because we have discovered that certain lines produce a small percentage of haploids. These are small minature plants which have half the chromosome number. however, these will cross with pollen from any apomictic line and produce normal plants which are F_1 hybrids and breed true. Using this procedure we now have a breeding method as effieient as other crops, or it may be more efficient.

At this hearing I would particularly like to emphasize the extreme urgency to continue funding the guayule commercialization program. The main reason is that natural rubber is a strategic material very necessary for our National Defense and for our National Economy. There is a predicted shortfall of Hevea natural rubber by the late 1980's and guayule natural rubber is our only reasonable substitute. We need a crop in the Southwest states which uses much less water than our present crops and guayule would work well. I believe that it is inevitable that guayule natural rubber will be needed in the future. It is much less costly to continue the guayule commercialization than to stop and then later to start again.

Assuming that the guayule commercialization program does continue, I would like to make some remarks regarding the future research direction. I believe that most projects in progress will need to be revised and continued. However, there are two areas that need additional support immediately. These are the breeding projects and a Research Pilot Processing Plant. The breeding program has the capabilities of doubling our rubber production within the

next four or five years and this could make guayule economically feasible. The need for a Research Processing Plant is even greater. This is in contrast to a Prototype Processing Plant which some other persons are recommending. A Research Processing Plant is needed now! It is needed to work out harvesting procedures, it is needed to work out processing procedures, it is needed to test the processing of new varieties, it is needed in the vicinity of growing guayule in the Southwest, and it will be needed for research even after guayule has been commercialized. The original cost of a smaller Research Processing Pilot Plant should be much less than a Prototype Processing Plant.

Inasmuch as one of the subcommittees are involved with International Agriculture, I would like to make some remarks in regard to guayule commercialization in other free countries. We have had requests for guayule seed and information from many countries and we have cooperated with them. There are many areas in the world that have arid or semi-arid regions where guayule could be adapted. Would it not be very wise that there would be a supply of natural rubber other than from the few Hevea countries if a shortfall occurs? Would it not be very wise that there would be supplies of natural rubber from a number of countries in order to prevent an "OPEC" of natural rubber. I would like to make a remark in regard to the situation in South Africa. When I was there last October they mentioned that their option in regard to natural rubber was guayule commercialization or the production of synthetic polyisopreme from coal. However, if they go the route of synthetic polyisopreme then they would have to put a tariff on Hevea natural rubber of at least 60 percent in order to make the synthetic rubber profitable to produce.

In closing I would like to acknowledge that there are other guayule projects in Arizona funded by NSF, Arizona State University and grower groups which I did not review, but with which we do cooperate. I would also like to acknowledge that accomplishments in our projects are partly due to close cooperation with the projects in California, Nevada, New Mexico and Texas. I also want to acknowledge the fact that this testimony was possible because I freely used information from several other project leaders.

Mr. BROWN. We thank you for your testimony.

I should indicate, in my own defense, that I didn't dream up this legislation on guayule out of thin air. It was a recommendation of the National Academy, that made a study about this issue. I just happen to be partial to the Academy, and I like to follow up on these things.

We have saved our best witness for last: Dr. Victor Youngner, who is from the Department of Botany and Plant Sciences at the University of California at Riverside, which I have the honor to represent.

Dr. Youngner.

STATEMENT OF DR. VICTOR B. YOUNGNER, DEPARTMENT OF BOTANY AND PLANT SCIENCES, UNIVERSITY OF CALIFORNIA AT RIVERSIDE

Dr. YOUNGNER. Thank you, Mr. Brown.

One of the fortunate or perhaps unfortunate aspects of appearing last on a panel like this is that much of what you planned to say has already been said by the other speakers. I find myself somewhat in that position this afternoon. However, what I would like to do in a few minutes here is to emphasize and possibly to even elaborate slightly on a few parts of my prepared statement which has been provided for you.

First of all, I want to say that I am convinced that development of a self-sufficient natural rubber industry in the United States

based on guayule is feasible. However, I am not sure that it can be accomplished with the production practices and plant materials presently available. To me, the key to success in this venture is research, especially research leading to the development of new varieties.

Some of us in research feel that rubber yields of the guayule strains now available are inadequate; that is, inadequate to guarantee profitable production under the present economic situation. A viable guayule industry that can stand in the long run on its own will demand new, superior varieties. That the yields of the guayule we have now are relatively low is not surprising. As I believe Dr. Rubis and others here have mentioned, we do not have any true varieties at the present time. We are still working with essentially a wild plant.

For profitable production we may need to approximately double yields presently obtainable with the wild plant. I think this and more can be done. To justify this optimism all we need to do is look at what has been accomplished with corn, wheat, rice, and almost any of our cultivated crops, over many years of time, of course. We might compare guayule as we have it today with the situation that existed many years ago with the wild Indian corn. We are dealing with a wild plant, perhaps very comparable to that, and look where we are today with corn yields.

Yields of today's varieties have, in most cases, been increased severalfold over those obtained many years ago in these other crops, and I know we can do this with guayule as well. We have the genetic base in guayule for such improvement. The same fact that makes the essentially wild material unsatisfactory for commercial production gives us one reason to expect success in breeding new varieties.

That fact is the large amount of genetic variation we observe in this material. There are undesirable types and desirable types; types with low rubber content, types with high rubber content; small, weak plants and large, robust plants; and so on. Such a mixture—and this is what we are using, to a great extent, right now—such a mixture in itself does not provide a good basis for commercial production.

However, from this pool of germplasm, plant breeders can select superior genotypes. In fact, researchers at several experiment stations—all of these represented here—have already made such selections, some of which may have much higher rubber content than that of the general run of guayule.

In addition to higher rubber content, we need to increase plant size and plant growth rate. Here again, progress has been made in the past few years. In the genus *Parthenium,* to which guayule belongs, there are a number of species several times the size of guayule. This genus is unusual in the existence of relatively few genetic barriers to interspecific hybridization.

Fertile hybrids have already been obtained between some of these and guayule. These hybrids are intermediate in size, growth rate, and rubber content. We know from years of breeding and working with other crops that by backcrossing these hybrids for several generations and selecting for high rubber content, large plant size, and other desirable characteristics, we can expect to

obtain new varieties with larger per-acre yields, and superior in many other respects as well.

Increasing the cold hardiness of guayule would expand its potential production area into vast semiarid regions of marginal agricultural value, but areas where summer rainfall might be adequate without irrigation. Here again, interspecific hybridization may provide one means whereby we can accomplish this. Several *Parthenium* species are found in the high Rockies and northern Great Plains. We have already successfully crossed one of these extremely hardy species with guayule, thus opening the way to the introduction of cold resistance into guayule.

At the University of California at Riverside we have a large collection of living plants of all of the Central and North American species of *Parthenium.* Many of these have traits that would be of great value if introduced into guayule. Two, perhaps three of these, actually contain some small amounts of rubber, and thus may be sources of new genes for rubber synthesis, and in that way provide pathways for increasing rubber content.

Since guayule production in arid regions will require some irrigation, we are conducting studies to determine irrigation strategies for efficient water use, while producing large plants with high rubber content. At the same time, we are selecting genotypes which appear to have superior water-use efficiency.

I have highlighted here only a few of the new developments in guayule research at the University of California in Riverside, and other agricultural experiment stations. We in guayule research find these events to be exciting and are confident that with continued effort, a guayule rubber industry will be possible.

However, for this to happen there must be a sustained effort. Breeding work, especially, takes time. Generation after generation must be grown and tested. There are, at present, no faster ways to do this. We are investigating such things as tissue culture techniques, cell suspensions, and protoplast fusion, but these methods are on the frontier of research and are not yet of practical use, so we go back to the tried and true breeding methods that we have developed and that have been responsible for the creation of many new varieties of other crops.

Large sums of money will not be required, but research programs—once established and showing progress—must be assured of sufficient funds to continue to a successful conclusion. This is especially important for breeding projects, because of the time element I have referred to.

This means the identification of meritorious research projects and assuring their support for a number of years, as long as they continue to show progress. Providing funds on a piecemeal basis, first for one project and then for another, cannot achieve this. A project, once established, must have some assurance of funding so that it can go on for the necessary number of years to accomplish the objectives of that project.

As I look ahead, I see the potential for a solid natural rubber industry in the United States. I see the possibility for much more than a stopgap measure to make up for future shortfalls of hevea rubber. However, the key to developing any kind of guayule industry in the United States is research. It should have top priority in

the future direction of programs authorized under the Native Latex Commercialization Act.

I believe the Native Latex Commercialization Act should be reauthorized and adequate funds appropriated for the final push toward a guayule rubber industry. Failure to do so would once again—as has happened so many times in the past—drop guayule research and the development effort, at the very time major advances can be seen ahead.

Thank you.

[The prepared statement of Dr. Youngner follows:]

Testimony of Dr. Victor B. Youngner,

University of California,

on the Native Latex Commercialization Act,

March 24, 1983

I believe that commercialization of guayule rubber production is feasible and important to the future well-being of the country. A domestic natural rubber industry in the United States based on guayule would provide us with as assured supply of an essential product regardless of events in the politically unstable Hevea rubber-producing areas of the world. It would provide us with a new water-conserving crop for arid regions of the West that are suffering increasing water shortages. Guayule commercialization would protect us from a world natural rubber shortfall projected for a few years hence and would ease pressures on petroleum for synthetic rubber manufacture. In 1978, the United States imported about 670,000 metric tons of Hevea rubber valued at $750 million and approximately 35 million bbl of oil for synthetic rubber manufacture valued at $500 million.

If the goal of successful guayule rubber commercialization is to be realized, we must have a sustained effort instead of the stop-and-go support that has characterized earlier guayule research and development. If the work of the Emergency Rubber Project of World War II, which was just beginning to produce results at the war's end, had been continued for a few more years, we might very well have a thriving guayule industry in the United States today. However, as you know, the project was dropped shortly after the war ended, the huge research organization quickly dismantled, and much valuable germplasm burned in the field. All that remains from the project today are the published papers and boxes of stored records. A small USDA research project was conducted at Salinas, California, from 1948 to 1959. At its termination, 25 seed lines were

sent to the National Seed Storage Laboratory at Fort Collins, Colorado. These lines provided the basis for the new research effort that began a few years ago.

Because of the "on again, off again" nature of guayule research, many years of scientific effort, in a practical sense, have been wasted. Now that we again have a program to develop this industry, we must provide adequate support over sufficient time to bring it to fruition. The objective of an economically viable guayule industry in the United States is possible but cannot be achieved overnight. Let's not, through impatience, drop support for the program now when it is really just getting under way.

Much has been accomplished since passage of the Native Latex Commercialization and Economic Development Act in 1978 despite meager financial support. The agricultural community and general public have been made aware of the potential of guayule as a new arid land crop and a new industry. Various agricultural enterprises are watching the research programs with keen interest, ready to begin development as soon as certain problems are solved.

It is in research that the greatest progress has been made during these few years. Starting from nothing but a few seeds, several university and USDA research programs have been established. These programs are staffed by experienced, enthusiastic, and highly qualified scientists. Their specific projects cover a range of agronomic, breeding, and biochemical studies all aimed towards making guayule an economically viable crop. Studies are under way on weed control methods; disease control; improved establishment methods, especially direct seeding; irrigation strategies for maximum rubber production with the most efficient water use; responses to saline soil and water; new harvesting methods such as pollarding; seed production methods; byproducts identification; use of chemical bioregulators to stimulate higher rubber content; and the breeding of superior varieties. Results of these studies are now beginning to come

in and represent significant steps towards efficient guayule rubber production.

A regional uniform variety trial is being conducted in Arizona, California, New Mexico, and Texas to provide further evaluations of the six top-rated strains from the Fort Collins guayule collection. As new strains become available from the several breeding programs, they will be included in this regional trial. Associated with the regional variety trial is a program to increase seed supplies of the six Fort Collins strains. Seed of these strains will be certified as true-to-variety and could serve as the beginning of commercial production. Seed from these plantings would assume especially great importance should an event occur that cuts off or severely restricts either our supply of Hevea rubber or the petroleum base for synthetic rubber. In such an emergency, economic considerations would be drastically revised, and large-scale plantings could be made immediately.

Despite advances made to date, continued research effort remains the key to eventual guayule commercialization under nonemergency conditions. I see two research areas in which work at an accelerated pace is absolutely essential. These are the breeding of superior high-yielding varieties and the development of efficient large-scale extraction and processing facilities.

Rubber yields of the best of the existing strains are inadequate under present economic conditions without some kind of government support or subsidy. With a few well-timed irrigations, maximum yields presently obtainable are approximately 500 lbs. per acre per year. Thus, under the normal 3- to 4-year production period, an acre would yield 1,500 to 2,000 lbs. of refined rubber. Dryland production would require several additional years to achieve comparable yields. Most agricultural economists believe this to be inadequate and that it will be necessary to double or more than double these yields if guayuule is to replace other crops on lands presently under cultivation, or move onto marginal lands not presently in cultivation.

Is such improvement possible? There is extensive evidence to indicate that it is. At the present time, we are working with essentially a wild plant. We might compare today's guayule yields to those obtained many years ago with the wild Indian corn or maize. Through simple selection first and later the development of hybrids, yields have been increased many-fold over those of the wild parents.

Hevea provides another example of what breeding can accomplish. Current production on the best of present varieties is 10 to 20 times that obtained not many years ago from the original wild trees. Of course, some of this increase is the result of advanced cultural methods. I believe similar yield increases are possible with guayule through the same combination of improved varieties and cultural methods. The genetic basis for such improvement exists.

Higher-yielding guayule varieties can be developed through one or more of the following approaches: increase the percentage of rubber in the plant tissue, increase plant size, or increase growth rate to shorten the production period by 1 to 2 years. Most likely, all three will be utilized in the best new varieties.

Although we have not produced a truly superior guayule variety as yet, we are well on the way. Studies have shown that great variability exists within guayule for rubber content, plant size, growth habit, and many other characteristics. Through simple selection within this variable guayule population, we may have already obtained lines with twice the rubber percentage of the best of the old Fort Collins strains. Collection trips into Mexico have brought back genotypes with the potential for very high rubber percentages.

Larger plant size and rapid growth rate can be achieved through hybridization with several large guayule relatives. The genus Parthenium to which guayule belongs is unusual for the existence of relatively few genetic barriers to interspecific hybridization. Fertile hybrids have been obtained between

several large species and guayule. These hybrids are intermediate in plant size, growth rate, and rubber content. Many years of experience in breeding other crops tell us that through further crossing and selection, rubber content of the hybrids can be increased and the larger plant size retained.

Increasing cold hardiness of guayule would expand its potential production areas to vast semiarid regions of marginal agricultural value where summer rainfall might be adequate without any irrigation. Here again, interspecific hybridization may provide the means. Several Parthenium species are found in the high Rockies or the northern Great Plains. We have already successfully crossed one of these extremely hardy species with guayule.

The Great Plains will be confronting a very serious economic situation in 15 to 20 years when a projected depletion of the Ogallala Aquifer will make continued large-scale irrigation impossible. The severe reduction of irrigated crop acreage, the most productive and profitable part of the area's agriculture, would cause widespread economic difficulties. A hardy, water-efficient guayule could be a new crop to help alleviate some of the social and economic distress.

I have cited here only a few of our recent guayule breeding accomplishments to show that optimism for the future creation of new high-yielding, well-adapted varieties is clearly justified. Similar gains in disease and salinity tolerance, seedling vigor, and other characteristics are possible. However, they will not be accomplished in a year or two. Time must be allowed because breeding new varieties is, by nature, a slow process. We have the example of accomplishments with virtually every major crop to show us what can be done with time and adequate support.

Techniques which can be grouped together under genetic engineering may someday speed the process; but although some work is under way with guayule, the basic techniques are yet to be perfected, and we are many years away from practical application. For the present, we must rely on the more traditional

breeding methods which have, after all, provided us with all our modern crop varieties.

The development of improved extraction and processing facilities is outside my area of expertise, but it is obvious that without such facilities, a guayule rubber industry is imposible. It seems to me that the major responsibility here lies with the private sector rather than with public institutions. Although I know that commercial organizations have been involved in guayule procesing research and development, little information has been made available on accomplishments. Incentives such as federal financing guarantees for processing facilities may be necessary to get this essential aspect of guayule commercialization off the ground. I believe that whatever it takes, it must be done and that it will, in due time, return great rewards to the country. Basic extraction and refining methods for guayule have been devised; what remains to be done may be primarily construction of the facilities.

The present Native Latex Commercialization Act has been an effective stimulus to guayule research and development. Its simple existence, by showing government support for the effort, has encouraged scientists to devote their time and energy to the problem. I see little wrong with the act itself, but its implementation or lack of implementation has been a disappointment to all of us involved in guayule research. Although $30 million was authorized for guayule research and development, as you know, only a few thousand have been actually appropriated. We can be proud of what has been accomplished with so little, but if we are to make continued progress, we must be assured of greater support over an extended period of time.

The Native Latex Commercialization Act should be extended and adequate funds appropriated for the final push towards a guayule rubber industry. Failure to do so would once again drop guayule research and development efforts at the very time major advances can be seen just ahead. This time it could be

the fatal blow destroying forever the chances of having a domestic rubber industry in the United States based on guayule.

We don't need another Emergency Rubber Project. We do need assurance of a modest level of support over a period of sufficient time to permit us to complete the work we have begun.

Although we are not at this time facing a crisis situation in respect to natural rubber or oil, it is imperative that we develop the technology now for a viable natural rubber industry in the future. I believe that with adequate support, development of such an industry is only a few years away. It could be one of the greatest boons to agriculture since the introduction of hybrid corn.

Mr. BROWN. This has been a very interesting presentation.

May I just quickly review the scope of the enterprise we are talking about. The projections we have for the importation of natural rubber in 1990 are roughly 1 million tons a year at a price of $1 billion, if rubber costs 50 cents a pound, or $2 billion if it goes up to a dollar.

The testimony is that for national security purposes, we ought to be able to provide roughly a third of that from domestic sources, which would indicate about 300,000 tons of rubber from guayule as a potential. Three hundred thousand tons would probably require about a million acres of planting as a reasonable effort, so we are talking about an ideal situation where we would have perhaps a million acres of guayule scattered around the arid lands of the Southwest producing 300,000 tons and supported by a half a dozen or more commercial-size processing plants. I am just guessing, but it would be somewhere in that order.

Ideally, we would like to do that before the next big shortfall of hevea rubber, which probably will be before 1990. The question is, how does a big country like ours focus its attention on this problem in such a way as to secure that result and move us to the position where the private industry and the agricultural base can take this over without Government intervention. We are in the phase now of research, development, and demonstration. That is the general situation.

Now, Mr. Skeen, do you have any questions?

Mr. SKEEN. Thank you, Mr. Chairman. I would like to continue on from your summarization and from what we have heard in the testimony this morning and this afternoon. I find a different kind of an approach, or a sort of a bias.

The Department people this morning were not overenthused about the idea of asking for authorization specifically but they did state—if I am not stating the response incorrectly—that they didn't feel that a reauthorization would be necessary, specifically because they did intend to fund these things. Did you gentlemen get the same idea, draw the same conclusion from what was said this morning?

I am a little concerned about that. It is not that I distrust the Department. I just have a feeling that sometimes a project such as this, that has a tremendous importance and a great impact on a strategic material—and we have become very sensitive to strategic materials through the years then we tend to let it drift off and forget about it for a while until something happens that draws our attention back. I am not at all comfortable because you have a 3- to 4-year program and the grants operate on about the same frequency. Is this not correct?

Therefore, you have a decision. I know that administrators of institutions are very fond of you folks coming up and telling them what kind of funding you are going to need. And, if you cannot give them any kind of a direct answer as to how well your project is going to run, is it or is it not going to affect whether or not it will be funded? Saying that, I would tend to think that maybe we should get a very positive response out of the Department of Agriculture and an assurance that your funding is there, so that you have something to plan on.

Now, if I might ask—none of you specifically but any of you that might like to answer—what is the status? You have given us a rundown from the Native Latex Act beginning with 1978, and you have had about 5 years now. At what point are we now in the first crops that have been harvested? Dr. Niehaus, I think you alluded to that. Have you harvested it, or at what stage are you?

Dr. NIEHAUS. Well, several harvests have been made of both seed and rubber, but we have not yet harvested a mature crop that is 4 years old, as Mr. Salisbury indicated, or even a 3-year-old crop that Dr. Rubis talked about. We have rubber yields from 1 year and 2 years but not rubber yields from what I am calling a mature crop, yet, from those grants. I am speaking for our State; I assume that is true of the other States.

Mr. SKEEN. I was astounded that Dr. Rubis says they have had enough experience—I am assuming that I am stating this correctly—that you find that you get your optimum production in 3 years or 4 years, somewhere along in there.

Dr. RUBIS. Well, I suppose I have to allude back to one of the questions I missed in an English test way back when I was a senior in high school, and so I never forgot it. It says, "Time is the inexplicable product of everything."

Mr. SKEEN. Let us in on that too, would you?

Dr. RUBIS. Therefore, the yield test that we harvested after 2 years and after 3 years and after 4 years, those yield tests were planted back in 1978. The plots were much smaller than we know we need now. They were small samples. They gave us a good indication of what we think is happening.

We are now planting yield tests that we should get better estimates, and those plants are now 4 years old. We have some of the first ones in 1977 that are now 5 years old, and they are real big ones. We do not know what 4- and 5-year-old plants are like. In other words, it is hard to know what a 5-year-old plant will do in a 4-year program.

Mr. SKEEN. Well, that is the point that I am really trying to arrive at. With one single planting under the auspices of the act

itself, you are just now at the point where you know that you have a lot of work to do——

Dr. RUBIS. Or how to do it.

Mr. SKEEN. And how to do it. Therefore, I think that the loss would be almost unrecoverable if you had to shut it down and go back to storing seed again.

Doctor.

Dr. NIEHAUS. Anybody who made a cross, of course, doesn't have plants in that long. If they started with one of these grants in 1978 and made a cross, they may just now be planting the progeny of that cross, so we are several years from those results.

Dr. DODD. I want to point out the same thing would be true of the collections that we made from the native stands where we had plants with 20-percent rubber. You collect a few seeds, then you have to go through the seed increase. Dr. Tipton tells me that we will have adequate seed this year, hopefully, to get them into observation trials throughout the Southwest in the uniform regional trials, but it has taken from 1979 to now to get our seed built up to where we could go that route.

Mr. SKEEN. Yes, sir.

This morning, also, the National Science Foundation said something about bioregulation and the influence on the synthesis of rubber in guayule. They have approximately a quarter million dollars in grant money somewhere. Does New Mexico State or Texas A&M or——

Dr. DODD. Texas A&M.

Mr. SKEEN. Do you have some of this grant?

Dr. DODD. Yes, sir.

Mr. SKEEN. Dr. Niehaus, do you have any?

Dr. NIEHAUS. We don't have any grant money to work on growth regulators. We have worked on whether or not the herbicide program is affecting rubber content—and so far I have determined it has not—which is related to the growth regulator work, but we are not working directly on regulators.

Mr. SKEEN. You are not, then, on bioregulators.

Someone mentioned—I think probably Dr. Rubis—about the Australians making a decision about which way they were going to go and——

Dr. RUBIS. South Africa.

Mr. SKEEN. South Africa. What about other countries? Is Australia one that is interested in——

Dr. RUBIS. Well, Australia doesn't have any oil or petroleum, so——

Mr. SKEEN. Yes, sir, so they are necessarily forced to——

Dr. RUBIS. Yes, they have a problem, too.

Dr. NIEHAUS. Dr. Whitworth on our faculty will be going to Australia in about a month to consult with them on guayule growing, but they are very interested.

Mr. SKEEN. While we are on this topic, in what other products has the United States as a part of Agriculture or any U.S. regulatory entity, invested research dollars, into commercial production of some natural resource of this kind? Have they been followed through to the marketplace? Do we have any precedent type of work in this area?

Mr. SALISBURY. Are you talking about recently?

Mr. SKEEN. Well, to your knowledge anywhere in the past.

Mr. SALISBURY. During the Second World War, of course, the Federal involvement in the immediate production of synthetic rubber would probably be the greatest parallel that you could have. If we had another emergency——

Mr. SKEEN. The petrochemical process?

Mr. SALISBURY. That is correct.

Mr. SKEEN. Yes. What about cambe—combi, cambe?—what is that?

Dr. NIEHAUS. The crop, crambe?

Mr. SKEEN. Yes, doctor.

Dr. NIEHAUS. Well, I am not sure whether it has reached fruition right now but it is ready to go and could be produced. It is a Brassica or a mustard plant which produces oil needed by the steel industry and by jet engines and high-temperature applications.

I worked on it in Ohio for about 10 years before I went to New Mexico. We had grants from Government and from various agencies, similar to the guayule program. It is one that is ready to grow, and I believe there were 4,000 acres of it planted in Kentucky last year, so it may be on the verge of taking off.

Mr. SKEEN. It is still in production?

Dr. NIEHAUS. Yes.

Mr. SKEEN. What is the crop, again, doctor?

Dr. NIEHAUS. It is called crambe, and it is a mustard.

Mr. SKEEN. C-r-a-m-b-i-e?

Dr. NIEHAUS. C-r-a-m-b-e, Crambe Abissinica is the Latin name.

Mr. SKEEN. That last one is not necessary as far as I am concerned, doctor. [Laughter.]

Dr. NIEHAUS. That is for the other scientists.

Mr. SKEEN. Give me the vernacular.

Dr. NIEHAUS. Therefore, it is an oil crop that is doing well and probably has no need for further large grants. I think the commercial companies have started looking at it. I am away from it now; I have been gone for 5 years, but it looks very promising.

Mr. BROWN. There are some comparisons here with jojoba. I know there is quite a bit of research through the agricultural research system on jojoba but it seems to be commercializing now fairly rapidly, although I need a little more information as to exactly how rapidly.

Mr. SKEEN. Mr. Chairman, I have to say that it is a success. Of course, you could imagine a jingle now with jojoba in it. However, I saw it on the shelves in the Washington area drug stores, and the big advertisement, "This is jojoba oil." It is some kind of an emollient for cosmetics or something of that kind, so it must be very catchy. Evidently it has arrived.

I want to thank you all. You have added a great deal. One last question: What is your opinion of the working efficiency of the joint commission? Has it worked well, Dr. Niehaus?

Dr. NIEHAUS. From what I know about it, and I have attended some of the meetings, it seems to have worked well, but I have a problem in knowing how things would have gone without the joint commission. I am looking to the future now. I really don't know what the effect of reauthorization or the lack thereof will have on

USDA funding. That is why I put a disclaimer at the end of my talk a while ago, that if reauthorization of the joint commission helps in USDA funding, New Mexico is for it, but I don't know what effect that will be.

Mr. SKEEN. Thank you. Thank you very much, and thank you, Mr. Chairman.

Mr. BROWN. Mr. Boehlert, do you have any questions?

Mr. BOEHLERT. No questions, Mr. Chairman.

Mr. BROWN. Mr. Salisbury, did you ever figure out how much seed Mr. Anderson has?

Mr. SALISBURY. Well, there are two ways of computing that, Congressman, the direct and indirect way. Mr. Anderson provided me with some information. There are 528,452,600 live, viable seeds which he has available. Now if you know the weight per seed, I think we can figure out exactly what the weight is. Now that is variety 593. Then there is 31,030,000 of a hybrid that produces 40 percent more rubber per acre than variety 593. We have to add that together.

Now you can do the calculation or you can go to a 1977 report, which was the only place I found that it said that he had 19 barrels or sealed drums of seed which contained about 2,000 pounds. That probably would be easier than going the alternate route. Therefore, we are looking at 2,000 pounds at $1,000.

Mr. BROWN. Well, 2,000 pounds at the rate of 60 pounds per 1,000 acres would give you how many acres? Basically I was just trying to figure out how many acres could be planted from that seed stock compared to the number of acres that we need to plant.

Mr. SALISBURY. Well, according to Mr. Anderson's estimates, he said he has enough seeds for 10,000 acres and the seeds are ready to plant as soon as the financing is available.

Mr. BROWN. I have forgotten which one of you gave us the interesting figures about guayule growing in water of a salinity of 3,000 parts per million. You said that?

Dr. DODD. Yes, sir.

Mr. BROWN. That is about three times the level that allows most vegetables to grow.

Dr. DODD. That is right. However, we got a 90-percent survival with that but we also had a significant reduction in growth.

Mr. BROWN. It reduced the rubber content or the rate?

Dr. DODD. It hasn't been in long enough to check the rubber content, but it reduced the biomass production.

Mr. BROWN. The biomass production?

Dr. DODD. Yes, the above-ground production. I am sure today we would probably agree that as you reduce the biomass, there undoubtedly would be some reduction in rubber content. There would have to be. We thought it was significant that you could produce it and could irrigate growth with that high a salt content.

Mr. BROWN. Well, that raises another interesting possibility. We have a number of areas, irrigated areas in the Southwest, where we have salinity problems. The availability of a crop that was tolerant to high levels of salt would save us, possibly, the cost of putting in expensive desalinization plants.

Dr. DODD. One of the things that is interesting about this, is that this reduced growth has occurred and it has been traced—and

again, going back to Mr. Skeen, these plantings are very young—and the reduced growth occurred due to damage to the foliage when it emerged through the salt layer on the soil surface. Now once it emerges above that, it may regain itself and go back to where we can get adequate biomass production. However, the initial cause—and this is one of the things we want to look at—the initial cause is burning, if you will, as it emerged through the high salt content of the surface layer.

Mr. SKEEN. Would you yield, Mr. Chairman?

Mr. BROWN. I would be glad to yield.

Mr. SKEEN. Dr. Dodd, you gave us so many parts per million of salt, the tolerance that you have gone to. Was that 200, 300, or what was it?

Dr. DODD. Under laboratory conditions they could germinate seed in 10,000 but when they went to irrigation, direct seeding, they could get establishment as long as they used either drip or the LEPA irrigation system and the water salinity was below 1,500 parts per million. At 1,000 parts per million, they get good establishment. At 1,500 parts per million, they ran into problems, so I just——

Mr. SKEEN. That begins to get to the edge of it?

Dr. DODD. Yes, sir, the 1,500 would be the upper end, the cutoff. That was from direct seeding, not transplanting.

Mr. SKEEN. Thank you.

Mr. BROWN. Committee staff would like to ask some questions.

Mr. O'NEILL. I just have a couple of general questions. I would like to address my first question to the panel: Have any of you observed any physical characteristics of guayule rubber that would make it, in fact, superior to hevea rubber? In terms of heat stress or whatever, are there any characteristics in that regard that make it superior to hevea?

Dr. NIEHAUS. From what I have read about it—and this is not from personal experience, this is from reading—it is equal to, and if you can measure things very accurately, slightly better than in some characteristics. However, I would doubt from the way you termed your question that I would presume it to be superior, but it is equal to.

Mr. O'NEILL. OK.

Dr. DODD. The word I get from my engineer is that in working with this, we perhaps have not had enough of it where we knew the actual process, and so on, that was used and the quality of the processing it went through. Maybe we cannot make an actual statement on that but the general consensus is that it will be equal to or superior, as Dr. Niehaus said.

Mr. O'NEILL. OK. Dr. Rubis.

Dr. RUBIS. Well, they differ in physical properties even though they are very similar in their chemical properties. I have been visiting with Goodyear and Firestone people, and I forget which ones have told me this—I have visited with them a number of times—and that is that hevea is a hard rubber. It has a hard green strength, and when you make a tire you hang it on a peg and it goes through and it gets vulcanized with carbon, but it is round because it is hard. If you did the same thing with guayule you would

have an egg because it has less green strength, so in that case it is inferior.

However, when you make the tire, hevea is harder and guayule is softer, and so if you wanted a soft tire that would flex at the sides to get good gas mileage, you would probably get higher gas mileage with a guayule. They tell me that, really, if they had guayule they would mix guayule and hevea in various proportions in using it for tires. In other words, they would end up with better rubber than they have now.

That is the story that is told to me. I don't do any of the work, but to answer your question, there are properties that are both ways.

Mr. O'NEILL. I see.

Dr. Dodd, I am interested in the Fort Stockton project. The data that is developed there, will that basically go to Texas A&M? Has Firestone voiced any interest in the data developed, or how will that be handled?

Dr. DODD. We are still completing the negotiations on the contract. They will provide us with all the background information and backup data that is needed to do adequate analysis. Then when we get into the patent aspects, and so on and so forth, those have been covered in the contract and are satisfactory to both parties. That has been one of the things we have been negotiating.

One of the exciting things about the Fort Stockton site is the fact that this will give us a 200-acre block of land with guayule currently on it, and some of these plantings are 4 years old at this time. I think another important aspect of it is, we were talking about doing surveys to locate germplasm for people like my two friends sitting down here on the end to do their work with. It is quite expensive and quite time-consuming to go out and find the native stands in these back areas of Texas.

On this Firestone site we have bulk plantings of seeds that have been collected from wild stands in Texas and in Mexico. We have them under intensive agricultural conditions. We can make our selections in these fields. By the way, you can see considerable difference from one plant to the next as you walk down the rows. We feel that this will certainly condense the time needed to locate germplasm that these gentlemen can use.

Mr. O'NEILL. I see.

Dr. Rubis, the blisters on your hands, is that from an agricultural implement? That is not an allergic reaction to the guayule plant, is it?

Dr. RUBIS. No. I was actually digging and cutting guayule last week.

Mr. O'NEILL. OK.

Dr. RUBIS. I could back the statement up if I had to. You want more information? [Laughter.]

Mr. O'NEILL. No, that is OK. Thank you. Thank you very much.

Mr. SKEEN. Mr. Chairman.

Mr. BROWN. Mr. Skeen.

Mr. SKEEN. Could we have our staff ask a question?

Mr. BROWN. Yes, certainly.

Mr. SKEEN. Thank you, sir.

Ms. BACH. I have a question for the panel. How familiar is the panel with the initiatives that the Department of Defense has taken, the $20 million grant that they have given out as of May 1982 to the Gila Indians? are you familiar with that effort?

Dr. RUBIS. In what respect? I mean, what——

Ms. BACH. Well, I am concerned, I am interested as to whether you feel that the Defense effort will enhance, affect, facilitate, deter, your efforts in research on the plant and its production for industry?

Dr. YOUNGNER. Well, I personally don't know a lot about it. I wish I knew more but from what I do know, I don't see where it is going to affect my research program. I don't think it is going to help it, nor is it going to hinder it. Maybe Dr. Rubis, since he is closer to the project, might know a little more about it than I do.

Dr. RUBIS. Well, I would hope that it would enhance our program. At the present time I would have to confess that the communication has been on the nil side. Some of the things, some of the original proposal that they had on some new lines and so on, one of the things that I alluded to in my testimony was the fact that we need to process true guayule types, and if we are going to make improved types we need to have a processing on these new types before we know what the standards are. I was sort of alluding to some of the things they were doing.

Ms. BACH. According to the testimony that we received this morning, in May of 1982 DOD initiated a program for establishing a prototype domestic guayule rubber industry. This was the effort in conjunction with the Gila Indians. I am curious to know what research effort might be necessary for the Department of Defense agreement. How would that research coincide with the research that you all would be doing? You are in Arizona; this is where DOD's effort is taking place. I would think that it would be to everyone's interest that whatever research is necessary to get this going be available to all the parties that are involved.

Dr. RUBIS. Well, may I put the question back, Bob? Was there testimony from Mr. Bill Miller? Is there a written one? Do you have a written one? I understood——

Mr. O'NEILL. Yes. I don't have it in hand right now. As a matter of fact, Dr. Miller called this morning to say that his original intention was to have the written statement here for us today but something had arisen and the statement has not yet arrived. We expect it within the next day or so, if not earlier.

He originally wanted to come and appear in person to give background on that situation, but was unable to do so because of some scheduling conflicts.

Mr. BROWN. We have asked that it be provided for the record, though, so that we will have it in the record.

Dr. RUBIS. If you had his statement I might make a comment on it, but I am not sure what his statement is, and so I——

Mr. BROWN. Well, I am not very sure either but my impression is that this is an actual demonstration of planting and harvesting rather than the more esoteric kinds of research that you gentlemen are engaged in.

Dr. NIEHAUS. I wanted to speak to that. I have been on the phone with Mr. Miller several times over the last month. We did, as a

result of those calls, get seed of the seven varieties you have heard mentioned to him, and he has access to virtually all the research that is available. As you pointed out, from my talk to him they are not going to do research on that project. They are going to go straight ahead into production.

Mr. BROWN. The amount of seed you have indicated wouldn't plant a very large stand, though.

Dr. NIEHAUS. They have seed of their own, also, and they are not going to get a tremendous acreage the first planting. They are going to have to increase seed and go a second round to get the acreage we are talking about, as I understand it.

Mr. BROWN. Therefore, they probably will start with, say, a couple of hundred acres and expand that as they develop a seed supply.

Dr. NIEHAUS. Dave, is that right, 200 acres they are starting with?

Dr. RUBIS. Yes. I just got that same figure. I figure a pound of seed to 30 acres.

Mr. BROWN. Yes. Tell me this, gentlemen: How fast can you multiply your seed in an operation like this, so that I could have a rough idea of what the logistics would be in expanding from a few acres to, say, 100,000 acres planting?

Dr. NIEHAUS. A pound will handle 25 or 30 acres in our conditions, and you can get a pound per acre off of that in one year. Do you agree?

Dr. RUBIS. Approximately, yes.

Dr. NIEHAUS. Therefore, 900 acres by the third year and on up. With luck you could have it in 5 years.

Mr. BROWN. I think I can calculate the time it would take.

Gentlemen, I have no further questions myself.

Did anyone have any further questions?

[No response.]

Mr. BROWN. You have been of great help to us in getting the full picture on this program. Hopefully we will be able to act intelligently on the matter before us as a result of your assistance.

Thank you very much. The subcommittee will be adjourned.

[Whereupon, at 3:45 p.m., the subcommittees recessed, to reconvene at the call of the Chair.]

APPENDIX

Additional Material Submitted for the Record

PACIFIC RUBBER GROWERS

PARTHENIUM RUBBER

FROM

GUAYULE

5 YEAR FINANCIAL PROJECTION

10,000 ACRE PRODUCTION

PACIFIC RUBBER GROWERS
1950 MILL RD.
SOUTH PASADENA, CALIF. 91030
(213) 799-1991

BACKGROUND OF THE USE OF THE GUAYULE PLANT FOR RUBBER

The Guayule plant was first used for a crude rubber by the Indians in Mexico and was later discovered by the Spanish explorers. It first achieved wide-spread industrial application when a group of financiers led by Bernard Baruch formed the Intercontinental Rubber Company in 1903. This $30 million company produced Guayule rubber from 1903 to 1945 from the Wild Guayule they found growing in northern Mexico and Texas. Their extraction process was not perfected and produced a too soft and impure rubber as they used a pebble or ball mill to extract the rubber, an adaption of a mining machine used for reducing ore. It recovered only an average of 65% of the rubber in the shrub.

With the entry of the U. S. into World War II, the U. S. was cut off from tree rubber supplies in Southeast Asia. Consequently, the U. S. Government purchased all the U. S. facilities of the Intercontinental Rubber Company in order to have some form of natural rubber. The war resulted in extensive interest in research in growing and extracting rubber from Guayule, and the Emergency Rubber Project of the U. S. Department of Agriculture had 33,000 acres of Guayule planted and under cultivation.

With the end of the war, all this acreage was, unfortunately, plowed up and the extraction equipment sent overseas. The oil companies began promoting synthetic rubber. It was proposed to the Government that they could procure rubber, still a strategic war material, more cheaply from petroleum derivatives.

In the meantime, the staff and associates of the predecessor company of Pacific Rubber Growers, Desert Rubber Co., continued to plant experimental plots of Guayule and to improve the breeding of the shrub so as to increase the amount of rubber produced per acre. In addition, they continued to make improvements to their extraction process, knowing that some day Guayule would again be a major source of rubber.

Now petroleum prices have escalated pulling synthetic rubber prices up as well.

Traditional natural rubber is able to be grown in equatorial regions, primarily Southeast Asia. This area is politically unstable, has escalating labor prices for the labor intensive Hevea rubber tree plantations and has significantly reduced allocated rubber tree acreage.

BACKGROUND INFORMATION

NEED FOR A NEW RUBBER

The diminished supply of the world's oil and the resultant higher prices in the world markets has resulted in a search for alternate sources of power and various means to conserve petroleum. About 70% of the world's rubber supply comes from synthetic rubber made from oil derivatives. Specialists are searching for adequate substitutes. A total of 10.1 million metric tons of rubber, both natural and synthetic, were utilized worldwide in 1973.

Rubber produced from the Guayule (pronounced "why-you-lee") plant, a desert shrub indigenous to the Southwest, has been found by agricultural specialists to be the most adequate and economic alternative source of rubber. Evidence of the concern and encouragement by the U. S. Government was shown by the sponsorship of an International Conference on the Utilization of Guayule in 1975 at the University of Arizona. Since that time, the Government funded a $20 million rubber growing program with the Gila River Indian Community in Arizona.

In March 1978, testimony was requested from the President of Pacific Rubber Growers to endorse legislation sponsored by Senator Domenici, "Guayule Demonstration and Economic Development Act of 1978." This Bill was approved in May 1978, authorizing funding in the amount of $30 million during the next five years with funding to be allocated by the Department of Commerce and the Department of Agriculture.

The world's natural tree rubber supply is being diminished as rubber tree plantation owners in Southeast Asia are starting to dig out their rubber trees and replace them with oil palms because of the increasing costs of the labor required for tree rubber. Reliable observers report rubber tree plantations' acreage has been reduced in excess of 20% during the recent years.

BACKGROUND OF THE COMPANY

Pacific Rubber Growers is a California corporation founded in October 1965 with predecessor operations in Guayule under the same ownership. It holds existing technical knowledge for the production of Parthenium rubber from the Guayule shrub. The firm also has a proprietory process for extracting 99% of the rubber from the cells of the Guayule plant. This proprietory

process is a continuous process and works by a chopping and cell disintegration system. The company has also utilized a special solvent which separates industrial chemicals in the rubber. The company maintained a large planting for several years and operated an extraction mill. Research based on this operation has continued during 35 years.

The company's staff consists of the most experienced scientists in both the growing and harvesting of the Guayule plant, and in the process of extraction. In addition, Pacific Rubber Growers has the only known commercial quantity of standardized Guayule seeds, sufficient for production of Guayule seedlings for over 10,000 acres. The company also holds detailed information for growers on the best scientific methods of planting, growing, and harvesting the Guayule shrub.

Confidence in the future of Guayule as the future world's source of natural rubber and in the capabilities of Pacific Rubber Growers has been expressed by one of the largest tree rubber growers in Malaysia who has awarded Pacific Rubber Growers an order for 10,000 tons of their superior Parthenium rubber at market price at time of delivery.

POTENTIAL MARKET FOR RUBBER

To replace the 10.1 million metric tons of rubber produced from both tree rubber and synthetic oil derivatives would require the growth of over 10.3 million acres of Guayule. An acre of Guayule produces about 3,000 pounds of high grade rubber once every four years. At a price of 45¢ per pound, this represents a potential $10.2 billion market for Guayule as it slowly replaces other forms of rubber. The use of rubber throughout the world has increased at an average rate of 8% per year.

In addition to its major use for vehicle tires, since Guayule rubber is particularly soft and flexible, it can be used advantageously for cements and frictions, adhesives, chewing gum, clothing, milking machine inflations, as well as many other products.

In addition to its rubber, Pacific Rubber Growers' proprietory extraction process produces other valuable by-products that are commercially marketable. These include a paper pulp from the bulk of the plant after the rubber is extracted, industrial chemicals resulting in an array of organic chemicals from paint extenders to pharmaceutical products from the resins which are removed to harden the rubber, and a carnauba-like wax and fertilizer from the leaves.

OPTIMUM PARTHENIUM OPERATION NOW NEEDED

Pacific Rubber Growers estimates that a minimum economic planting of Guayule is 10,000 acres in one area. However, due to the great profitability and the tentative commitments of large sections of land, they propose to develop a 100,000 acre Guayule plantation, especially because of the increasing need for natural rubber and an assured market, the success of an undertaking of this size is all but guaranteed. As mentioned earlier, the Government has granted a $20 million guarantee for the development of Guayule rubber through the Defense Department. Legislation requires a natural rubber stockpile of 500,000 tons. Currently the inventory is approximately 100,000 tons. Previous encouragement by Hugh Anderson has resulted recently in joint exploratory work between the Australian Government and the U. S. Government investigating the feasibility of devoting large land areas in Australia to this crop. As further evidence of foreign government interest in this crop, we have sold seed to India, Argentina, Kenya, Sri Lanka, Israel and Russia. The confidence in the future of this crop is substantiated by the purchase order we hold, mentioned earlier, from one of the largest tree rubber growers in Malaysia. We understand this private company has purchased land in Australia to initiate their own planting in the future.

The quality of rubber from Guayule is equal and/or superior to any other known source; the by-products are of substantial value, and Pacific Rubber Growers has detailed plans for the construction of the extraction and processing facilities. All these factors are making this project economically attractive.

The Guayule shrub requires a minimum of four years of growth before harvesting so the first crop would not come until four years after the first planting. The plant must be plowed out and baled and the shrub hauled to the factory for processing.

ESTIMATED COST AND POTENTIAL RETURN FROM PARTHENIUM RUBBER

Pacific Rubber Growers estimates that an investment of approximately $30 million is required to finance the Parthenium rubber production from Guayule on a 10,000 acre estate. The investment would provide for the construction of an automated extraction mill, adequate irrigation system, e.g., drainage system, capitalization costs, and operating expenses for the first five years until the first crop of rubber and by-products is produced for marketing.

Return on a per acre basis includes 3,000 pounds of rubber at a price of $1,350.00 (45¢ per pound), four tons of paper pulp at $450.00 per ton, industrial chemicals from the resins (value equal to that of rubber) and waxes and fertilizer from the leaves. The average total cost for the initial 5 years for Guayule planting, cultivation and extraction will run to slightly less than $1,500.00 per acre under the program plan presented.

Pacific Rubber Growers stands ready to handle sales and marketing for the rubber and by-products, based on its many previous contacts with rubber companies and other corporations.

COUNTRIES IN WHICH GUAYULE CAN BE PLANTED AND HARVESTED

As a two-foot high desert shrub, the Guayule plant can be planted and grown throughout the world between the 20th and 40th parallels.

It can be grown on marginal lands not otherwise useful for food cultivation. Guayule requirer only a sandy, well-drained soil with rainfall or irrigation of between 12 and 20 inches each year and a several month period of drought during the summer to stimulate the rubber production in the cells of the plants. The effects of stress resultant from heat, direct sunlight, and drought combine to create rubber development in the Guayule plant.

Countries which have land which meet the climatic and soil conditions for Guayule include the southwestern United States and parts of Hawaii, Australia, Mexico, Argentina, Spain, Turkey, Saudi Arabia, Algeria, Libya, Egypt, Tunisia, Iraq, Iran, Union of South Africa, India, Pakistan and China.

PACIFIC RUBBER GROWERS

1950 MILL RD.
SOUTH PASADENA, CALIF. 91030
(213) 799-1991

BOARD OF DIRECTORS

Hugh Harris Anderson, President. Stanford University, Economics, licensed accountant. 1946 Founded Desert Rubber Co., to handle 1150 acres of Guayule. Constructed new type extraction mill. Pacific Rubber Growers formed in 1964. President of Agricultural Communities Foundation. Appointed Consumer Counsel to Governor for Southern California in 1964. Active in philanthropic organizations.

Charles Mackintosh, Vice President. Colorado College (Cum Laude) B.S. Civil Engineering, M.S. Civil Engineering. California Institute of Technology M.S. Civil Engineering. Recognized authority on structural design. Active in many civic and non profit organizations. Partner in Engineering firm of Mackintosh & Mackintosh, Inc., Los Angeles. Currently serves as Vice President of firm.

Richard Anderson, Vice President. Stanford graduate, Keio University, Japan, U.S.C. M.D. Practicing in Ojai, California, specializing in obstetrics and gynecology.

Lewis D. Burwell, Secretary. Real estate investments. Formerly consultant to L.A. City Schools.

Eugene W. Wiegel, Member, graduate accountant, former bank president, 50 years banking experience. Corporation financial consultant.

BOARD OF ADVISORS

A. W. Bartel, Chief Chemist, retired, Uniroyal, Inc., Los Angeles, California.

Harvey Christen, formerly a member of Lockheed senior management.

Frank Kuwahara, Manager & Vice President, Southern California Flower Market.

Walter Nestler, formerly of the Chief Engineer's Office, Pacific Tel. & Tel. Co.

Fred Williams, Chemist & Independent consultant in rubber technology.

8/78

PACIFIC RUBBER GROWERS
1950 MILL RD.
SOUTH PASADENA, CALIF. 91030
(213) 799-1991

SPECIALIST CONSULTANTS

George Arndt, Jr., A.A., Pasadena City College. Data processing equipment designer. Highly experienced in data processing as equipment designer. Associated with Caltech.

Tim Branning, B.A., Journalism magna cum laude, Cal State University of Long Beach. Public relations and free lance work with various museums, including George Page Museum. Directs public relations firm concentrating on educational films.

Mohamed I. El-Gafi, B.S., Mechanical Engineering, Cairo University, Cairo, Egypt. Graduate studies, Monash University, Melbourne, Australia & UCLA. Project engineer, assisting in chemical analysis & extraction mill techniques of Guayule.

Frank Hirosawa, Japan trained rubber chemist. Director of Laboratory for Furane, Inc., & American Can Co., Los Angeles. Mr. Hirosawa was active in Manzanar development and helped construct post war rubber factory at Beaumont, California.

Shimpe Nishimura, Ph.D., in Nuclear Physics at University of California at Berkeley. Extensive research and experience in plant physiology. Original work on photosynthesis with Drs. Rabinowitz & Robert Emerson at University of Illinois. Collaborated with Dr. Emerson in original Guayule discoveries. Expert in plant propagation. Headed up Manzanar Guayule research work at the Relocation Center, developing Guayule discoveries, including the new extraction process.

Fred Williams, Rubber Technology Consultant in chemical analysis of Guayule rubber. U.S.C. trained rubber technologist. Praised by Dean of School of Engineering. Consultant to rubber companies in Southland.

PACIFIC RUBBER GROWERS

1950 MILL RD.
SOUTH PASADENA, CALIF. 91030
HUGH H. ANDERSON, PRESIDENT
(213) 799-1991

Our efforts for the past 35 years, since we worked in consultation with the Emergency Rubber Project management would allow us to claim experience in the field of Parthenium argentatum and its related hybrids. We have planted and grown Guayule, including the management of 1,150 acres of shrub, built a processing plant that produced natural rubber with the highest quality seen heretofore, and during the course of our pioneering this product towards its establishment in the United States and following the sound recommendations of the Army Survey Team in 1930, have acquired probably more information on the subject and certainly more experience than any others.

We want to make this experience and data available for the establishment of a new rubber industry in the United States which will amount to many billions of dollars a year. We offer the following for sale and use:

I. Seeds, 528,452,600 live viable seeds as described hereafter:

   A. Variety 593, which was saved by the E.R.P., as being their most desireable rubber producer.

   B. 31,030,000 of the above mentioned seeds represent a hybrid that was reputed to produce 40% more rubber per acre than variety 593.

II. Library, consisting of:

   A. California Institute of Technology Guayule material.

   B. Japanese/American documents describing their pioneering work:

      1. First hybrids
      2. First planting of cuttings
      3. First new extraction process
      4. First economical extraction of resins from the rubber

   C. The most complete data and articles from the Emergency Rubber Project, including:

      1. Personal library of Project Director, Major Evan Kelly
      2. Library of Dr. David Spence
      3. Miscellaneous data from other sources

III. A new extraction process which makes Guayule rubber commercially viable for the first time.

I. Seeds:*

Our seeds have been tested three times, twice by the Los Angeles County Arboretum and once and finally by the Ransome Seed Laboratory in Santa Barbara, at which time the barrels were permanently sealed by the Los Angeles County Agricultural Commissioner. The inspector examined our seeds and declared them free of pests and disease, extracted the seeds for testing by Ransome Seed Laboratory, and then sealed the barrels with new rubber seals. These seeds were purchased from the U. S. Department of Agriculture after the conclusion of the E.R.P., and had been preserved under the guidance of Dr. Hammond at Salinas.

II. Library:

The Cal Tech data came from Dr. Robert Emerson who sponsored the Manzanar Relocation Center experimental work on behalf of Dr. Robert Millikan and the California Institute of Technology.

The material from the E.R.P.; arose through acquisition from the management of the E.R.P., including Dr. Carl Taylor, Dr. H. Tysdal, Ken W. Taylor, George Miller, Dr. Reed Rollins, H. M. Benedict, Dr. I. C. Fuestel, and many others.

Letters, articles, etc., from Dr. David Spence, who was Vice President of Intercontinental Rubber Company, Chairman of the World War II Natural Rubber Advisory Committee and winner of the Goodyear Medal.

III. Our extraction process can be compared to that used by the Intercontinental Rubber Company and/or the E.R.P., has improved in the following comparative items:

	Government Process:	New Process of Pacific Rubber Growers:
1.	Batch process requiring cleaning of equipment periodically.	Continuous process, even when a unit breaks down.
2.	Slow throughput taking hours.	Rapid throughput done in minutes.
3.	Recovery 65%, per Miller study of E.R.P., and 5 wartime companies operating in Mexico.	Recovery 99 to 100% of available rubber contained in shrub.
4.	Rubber contains 11% insolubles on average.	Rubber contains .02 to .05% insolubles
5.	Tensile: ICR under 3,000 psi E.R.P., 3,750 psi	Tensile: 5,200 psi per Dr. C. E. Bradley, U. S. Rubber Company
6.	Ageing: Complete breakdown to flowing mass within months	Ageing: Without the addition of antioxidants was held 25 years in unvulcanized stage and retained form to be processed satisfactorily.
7.	Power consumption: 100 units per "a" rubber unit.	Power consumption: 7+ units per "a" rubber unit.

III. Extraction process (Con't.)

Our process will produce immediately useable high quality kraft paper pulp and resins which Dr. I. C. Fuestel represents may be equal in value to the value of the rubber produced. In addition, the leaves will be extracted of their high quality wax. It is projected total recovery of all by-products will be equal to the cost of producing the rubber and the by-products.

We introduced the potential for Guayule rubber useage to the Mexican Government in 1964 and are very familiar with their process at Saltillo. Considerable interest has been expressed by Washington, D. C., in this endeavor because it is an improvement over Guayule rubber of the past. it does not meet our standards.

Quality of Pacific Rubber Growers Parthenium Guayule rubber found to be high quality by the following:

A. U. S. Rubber Company, now Uniroyal
B. Crown Rubber Company, Pasadena, Ca.
C. Bettis Rubber Company, Whittier, Ca.
D. Reeves Rubber Company, San Clemente, Ca.
E. Vanderbilt Rubber Company, New York, N.Y.
F. Voit Rubber Company, Santa Ana, Ca.
G. Muehlstein Rubber Company, Los Angeles, Ca.
H. Kirkhill Rubber Company, Downey, Ca.

For paper - - - Adamson Engineering Corp., Pasadena, Ca.,Crown Zellerbach Corp.

We present the above inventory of our assets for your consideration.

SUMMARY FIVE YEAR FINANCIAL PROJECTION - 10,000 ACRES

	Per Acre	-1 year	Year 1 2,500 Acres	Year 2 10,000 Acres	Year 3	Year 4	TOTAL
NURSERY							
Field Headquarters, construction		70,000					
Nursery property		60,000					
Nursery operations		150,000	300,000	150,000	150,000	150,000	
Technical consultation		25,000	25,000	25,000	125,000	125,000	
		305,000. . .	.305,000				
FIELD OPERATIONS							
Land, lease, taxes	135		337,500	1,350,000	1,350,000	1,350,000	
Clearing, discing, etc.	19		47,500	142,500			
Field preparation	29		72,500	217,500			
Planting	433		1,082,500	3,247,500			
Weed control, insecticide	20		50,000	200,000	200,000	200,000	
Contract farming	33		82,500	330,000	130,000	330,000	
Water, wells, maintenance	67		167,500	670,000	670,000	670,000	
Management	54		135,000	540,000	540,000	540,000	
Harvest and hauling	105					1,050,000	
Administration expense			25,000	25,000	25,000	25,000	
Factory engineering			260,500				
Factory construction					7,000,000	100,000	
Factory operation						3,000,000	
Contingency expense			109,500	1,102,000	110,000	1,160,000	
Funding required			3,000,000	8,000,000	10,300,000	8,700,000	$30,000,000

Above data is based on figures from cooperative efforts of the U.S.D.A. at Salinas, California; a large vegetable grower in the San Joaquin Valley, California; and a farming operation in Arizona known as Farmwest Services, Inc. In addition to our experience in factory construction (1948). Current estimates have been provided by two different engineers.

INCOME FROM SALES:

Rubber sales, 30,000,000 pounds @ $1.00 per pound	$ 30,000,000
Paper pulp, 30,000 tons @ $450.00 per ton	13,500,000
Resins, related to rubber sales, reduced 50% for conservative estimate	15,000,000
Wax, soil amendments @ $105.00 per acre	1,050,000
TOTAL	$ 59,550,000

4th - 5th Years: Rubber receipts based on 750 pounds of rubber per acre per year at a projected price of $1.00 per pound (optimum agricultural conditions can produce 1,000#/acre according to Dr. David Spence's experience while with Intercontinental Rubber Co.) Market price 2/83 - 41¢ per pound, 10/78 - 87¢ per pound

Paper pulp receipts $450.00/ton, 3 tons per acre

Industrial chemicals: Opinions of Dr. Irving Fuestel and Ken Taylor both of the U.S.D.A., chemicals in the resins are more valuable than the rubber

Seed, waxes and soil additives are computed at a nominal $105.00 per acre per harvest

THE PLAN:

Plant nurseries -1 year in early summer

Plant 2,500 acres from nurseries in year 1

Plant 7,500 additional acres in year 2

Care for 10,000 acres in year 3

Finalize engineering plans and begin mill construction in year 3

Finish our test milling operations and complete machinery for resin separation & pulp drying for shipment in year 4

Begin harvest on monthly basis and operate mill in year 4-5

Prepare rubber by further deresination and packing for delivery to issurers of purchase order to Pacific Rubber Growers for 10,000 tons of Parthenium rubber (Sime Darby Co., of Malaysia, largest tree plantation owner)

Note: Cost of money and further inflationary influences not shown

to Pacific Rubber Growers

TO INITIATE THE FOREGOING PLAN there may need to be preliminary and immediate funding of $350,000 for determining from the Association of Natural Rubber Producing Countries (ANRPC) the probable rubber price five years hence and total field equipment costs in addition to standard equipment already available, engineering costs for mill to update those on hand and to fully establish and support a contract for the project to provide an initial demonstration Guayule rubber plantation and factory for the United States

STATEMENT OF HUGH ANDERSON
President of Pacific Rubber Co., Inc.
March 24, 1983

It has been since 1942 that I have been involved in Guayule. My involvement has been challenging, interesting, even exciting -- and extremely frustrating. Obviously, you're not here to hear the story of my life and its frustrations, but I can assure you that there hasn't been anybody in the country who has tried harder to introduce the subject of Guayule than I have; and I suspect who has been treated more badly by the government. Under the guidance and suggestion of Senator Hubert Humphrey, I was visited by a group of men, headed by one particular man in charge from Washington, to hear the Guayule story as we were able to present it. What he reported back for the record was exactly the opposite of everything I said.

We have been in a position to produce quality rubber of Guayule rubber, it's been said by seven to ten different rubber-producing manufacturers, superior in some respects to tree rubber. The government just allocated a few more million dollars for the research on extraction. Can you develop better rubber than what we have done? No, I don't think it's possible. Our process for extraction uses the 7%, or 1/14 of the power of the process used by the government during the war. These are not our figures -- these are the government's figures on an analysis just before they closed down.

We have a higher tensil test in pounds-per-sq.-inch of at least 8% according to Uniroyal Tire and Rubber Company. No one has matched that figure, and no one has an extraction process similar to ours that achieves this kind of rubber. We did not patent it because Lyon & Lyon, the patent attorneys of CalTech, said "don't patent it because you aren't big enough to protect

the patent. Simply make it available for the public domain and keep it close to your chest so others don't know how to do it." At the end of the war, I built a rubber factory on the basis of a purchase order that was arranged for my company by William L. Batt, who was Chairman of the Inter-Agency Policy Committee on Rubber, and also Vice-Chairman of the War Production Board. He was giving a break to the Wrigley Chewing Gum Company to buy rubber which it could not otherwise buy legally, as non-essential users of a war product. He did it for us in order to help get a new rubber company started for the benefit of the company. After building a factory, sitting in Mr. Wrigley's purchasing agent's office with our first 200-lb. sample of rubber (which, at first, he didn't believe was Guayule because it was such good quality), I was told that the government had just given permission to Wrigley to buy rubber from the stockpile at 17½¢ a pound.

The country was then at its lowest ebb of inventory of natural rubber; but, nevertheless, this was given to Wrigley, and to absolutely no other non-essential users. The result, of course, was to cancel our purchase order for one million pounds of rubber at $3/lb. Congressman John Phillips, from our district in California where our factory was, wrote a letter to me to let me know that the oil companies had achieved their goals in eliminating Guayule as a competitive rubber to their then-beginning synthetic rubber industry. (I might just parenthetically say I was also stopped in Turkey, Spain and Western Australia by producers of synthetic rubber. I sent my data to China, but had no results from that. I figured China was the only place not yet controlled by the oil companies.)

I developed considerable interest in Western Australia and the subject of Guayule because it is ideally situated for growing it. Tests were conducted over a period of years and, on my fourth visit

down there, I was told that, all of a sudden, they weren't going to be able to give me land that they had committed to me by written agreement, amounting to around 200,000 acres. They had also promised $1 million, matching 20% on what I would provide, and railroad access, utilities to the door of our factory, etc. I was pretty disappointed when I couldn't have title to the land because, obviously, that was what the investment from the States was based on -- and it was kind of a foolish excuse because that's about all Australia has is land which has never been stepped on -- or even seen, I suspect, except by airplane. The country, as you know, is about the size of the United States, but it only has the population equal to that of southern California.

At any rate, as I left the country, I paid my social respects to the Deputy Prime Minister of the Commonwealth, who I knew socially, Mr. John McEwen. He said, "You know, you accomplished one thing out in the west with your work on rubber -- you got the synthetic rubber producers to put in their synthetic plant two years earlier than they had planned." That gave me reason enough to come home and have a heart attack.

Forgive all this diatribe on my experiences, but I have represented the best skills in the country in the knowledge of Guayule, as evidenced by the fact that we have produced the best rubber that has ever been produced from Guayule -- or from any other source for that matter -- in a very economical way, with an extremely efficient factory which would be continuous in operation and not be batch operation as was done by the government and the old Inter-Continental Rubber Company; and I also represent skilled growers on the subject of farm production of the shrub. Most of these skills have been lost by death of my compatriots; but, fortunately, we have the only remaining seed that the government paid $1.5 million for and which was grown through two cycles to prove its stability, and

we have enough of that for 10,000 acres -- or, parcelling out to many other local farmers who should be very much interested in this if the government would give them the "green light". I might say that there are hopeful signs. There is good seed for Guayule now being produced in small quantities and, before long, this will be available in large quantities; and, by the end of four years, we will have the first cycle of its growing to find out whether it produces rubber or not, and the possibility of regrowth to check that out. Each year that this country does not produce rubber for its own use involves an outlay of several billion dollars, so time is of the essence, as it has been for so long.

Some many years ago, I recommended to the Committee on Agriculture that a private group be allowed to have finance from the government on that basis so that it could just simply go out and prove to farmers that Guayule is a good product and a highly economical one. Our byproducts will pay for the rubber; the rubber will be free. I was asked how much would be needed; I said $15 million (about five to seven years ago). But, if the government was going to be involved in it, then it would have to appropriate at least $30 million. A bill was passed authorizing the use of $30 million for the growth of Guayule, but the Department of Agriculture has seen fit to do nothing about it, except to have many committee meetings and many trips around the country, and diddling out small amounts to research on learning how to extract rubber, etc. This has all been extremely frustrating to someone who already has most of the answers and who would be happy to impart them to anybody who is interested.

At the present time, I have two farmers with 10,000 acres, highly skilled and highly qualified in their area of Arizona serving on such committees as the Board of Education and Soil Conservation Service, etc., in their area, respected by the bank, who are eager

to plant Guayule. But they have to eat for the next four years while there is no income from the Guayule. If this is not of interest to the government, then there certainly is no interest in starting an initial program for the proof of the economic value from all possible standpoints in the use of Guayule. Piddling attempts will be made to give contracts to the Indians who have never had a measure of success in their operations of this kind. I worked with the Indians at great length a few years ago in conjunction with the cousin of Senator Hubert Humphrey, who was then in charge of the Southwest Indian Bureau Production of New Crops, but we got nowhere at all. The representative of the Governor of Arizona participated in the meetings with us and he said he would do anything possible through the Governor's office to help the Indians if they would just write him a letter. They didn't write the letter. I met with farmers in the southwest, in fairly large meetings with local agricultural representatives of the Department of Agriculture, county farm agents. Everyone was enthusiastic about the possibility of Guayule, but they saw no way of carrying the burden on it themselves for the necessary four to five years until the rubber was sold, at which time they would be in the gravy.

My function from here on out will be purely advisory; no way will I go down to lead a project involving the planning of many thousands of acres. I simply don't have the strength left to do it. But, it's my good fortune to have found young farmers who can do it and we can put the picture together very solidly to prove to this country that something really can be done in the growth of rubber for our domestic benefit. I hope this Committee can prevail on the Congress for real action. Our byproducts are, incidentally, high-quality paper pulp for craft paper particularly (which is the strong paper), and the chemicals involved in our resin are reported by the Department of Agriculture to be probably as valuable, if not more so, than the rubber itself; there is also the potential for wax, which has a quality somewhat higher than

carnauba wax (it's white; carnuba is yellow), has a slightly higher boiling point. There is a big market for wax. The gathering of wax in northern Mexico has fallen off because the candalega wild bush has just about been exploited to its limit, so there is a good market for wax as well certainly as paper, as you would know, and certainly rubber in another five years, if we ever get off dead center and start selling cars and the major uses of rubber.

Rubber achieved a price of $.87/lb. before the depression. It could readily go back to $1/lb., and that, of course, would make Guayule very, very economic, and probably would reduce the price of the cost of tires by about one-half for the ultimate buyer.

My associate in Pacific Rubber Growers Company stand ready along with me to be of any help we can to this Committee and to the government in the establishment of the Guayule program. This has been a lifelong project and lifelong ambition, and it got started by the recommendation of the great President of the California Institute of Technology -- Dr. Robert Milliken, who recommended strongly that I try and help with this because it really is a major industry for the future, as soon as people can understand it and involved in it. He went public on the subject in 1944, only 14 years after Dwight D. Eisenhower made his recommendation for a domestic rubber program.

Considering the improvement in quality since Major Eisenhower made his recommendation, this is, without question, a fantastic subject; yet, I cannot understand why it is not well on its way. We would be willing to sell our seed and our extraction process and make it available to anyone who would be interested in using it. If the government picked it up and passed out seed to various farmers, it would be a very, very smart move, because this seed is guaranteed, and our extraction process is proven.

I thank you for your attention and I would like ever so much to have the satisfaction of knowing you are going to be very positive in the efforts we have made and that you will now be making.

Thank you very much.

WRITTEN STATEMENT OF DR. DANIEL M. BRAGG, P.E., PRESIDENT,
THE AMERICAN PETROCULTURE COMPANY, A TEXAS CORPORATION

Mr. Chairman, members of the joint panel:

My name is Daniel Bragg and I would like to offer the views of a small businessman on the status of guayule development and on the prospects for the eventual establishment of a thriving domestic natural rubber industry in the United States. These views may conflict with those expressed by academia, government, and the traditional rubber industry; however, the present impotent state of guayule development may very well be a result of the prevailing views that have existed since passage of the Native Latex Act of 1978.

There is no need to dwell in detail upon the reasons why we need a domestic natural rubber production capability. The testimony given in support of the Native Latex Act in 1978 is still valid, albeit with some adjustment of timetables resulting from the worldwide recessionary influences of the past few years. Today, it is necessary only to reiterate the strategic self-sufficiency and trade balance issues as continuing justification for establishing a guayule industry within our borders. However, before such an industry can happen, it also is necessary that we reevaluate our assumptions concerning the approach considered most likely to achieve this goal and, as an integral part of the evaluation, to redefine the appropriate roles for government, academia, and the private sector in the undertaking.

Although natural rubber is a strategic material and should continue to be stockpiled, it is not necessary to "let the government do it all." Conversely, even though guayule has a strong commercial potential, it is not realistic to "let industry do it all." A compromise is necessary, and there

is considerable doubt that the existing legislation has provided such a compromise.

As much as "guayuleros" everywhere appreciate what Congress tried to do for the industry in 1978, the less-than-successful results indicate that the Native Latex Act did not go far enough. One major problem has resulted from the way in which responsibility for administration of the Act was split among several governmental branches. "Too many cooks" have significantly impeded implementation of the program.

Another problem with the 1978 Act resides in the failure of the legislation to provide incentives beyond the R&D stage. The axiom "paralysis by analysis" could well be applied to the result; as long as funds are authorized in only one functional area, in this case R&D, then all of the effort will occur in just this area.

The importance of incentives for the production stage is underscored by the fact that, even though it is agreed that guayule rubber could be a strong competitor to imported rubber once our domestic industry is established, there is no way that it can compete during the industry start-up phase. It is perfectly proper to have "government" involved during such a developmental period. Unfortunately, there exist many detractors who cry loudly at the prospects of federal "support" of prices and federal purchase commitments to help get guayule started, because this would "set a precedent." Yet, the idea might be more acceptable if it could be pointed out that many of the expansions and replantings of hevea trees throughout the world nowadays typically are instigated through government programs.

At the present time, several private sector ventures like the American Petroculture Company (APEC) are exploring the possibilities associated with commercial production of guayule rubber in the United States. Just as with

APEC, however, most if not all of these entities are fully aware of the fact that venture capital will be extremely difficult to acquire unless some fundamental changes occur. And, coincidentially, all of these changes require action on the part of the federal government.

The most significant of the actions are as follows:

(1) Steps should be undertaken, starting as soon as possible, to place at least 100,000 tons of guayule rubber into the strategic stockpile.

(2) Guayule rubber acquired for the stockpile should be purchased at a price sufficient to cover reasonable development costs associated with industry start-up.

(3) Over a reasonable phase-in period, federal procurement standards and regulations affecting any product that normally must contain natural rubber should be restructured to require a certain minimum content of "native latex" in all such products purchased by the federal government. This will help ensure continued demand for guayule.

(4) Some form of start-up or planning funding should be made available for private ventures, to complement the R&D funds that are authorized by the Native Latex Act.

In regard to the Native Latex Act, a certain amount of restructuring is needed in order to improve its effectiveness. I would like to recommend the following moves:

(1) Place all administrative responsibility for the Act into one branch of the government, in order to improve decision-making and response times involved with potential guayule projects.

(2) Allocate a significant portion of the remaining money authorization to non-R&D purposes, including planning and start-up assistance to private ventures.

(3) Amend the Act to provide for a purchase commitment at a "developmental" price for a specified amount of guayule rubber for both evaluation and stockpiling purposes.

(4) Take steps to ensure that authorized funds are actually made available.

If the recommended changes given above could be made, the roles of government, academia, and the private sector in the development of a domestic natural rubber industry would become much better defined. Government would be the motivator, while private industry would be the ultimate innovator and risk-taker. Academia would be reinforced in their role of researcher through support from both the public and private sectors. And, the goal of self-sufficiency in a strategic material would be reached much sooner than it will be, if ever, under the present set of conditions.